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PEROMYSCUS RANGES AT HIGH AND LOW POPULATION DENSITIES

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Population density and ranges of wood mice, *Peromyscus leucopus*, were measured by live-trapping in 1954 when mice were unusually scarce, and again in 1957 when the mice were more abundant. The trapping area, which was the same in both years, was in the bottomlands woods of the Patuxent Wildlife Research Center, Laurel, Maryland.

Although it long has been recognized that the ranges of small mammals vary in size (Dice, 1938, 1941; Burt, 1943), some workers still tend to think of home range as more or less constant for each species. The present study shows differences in range of a single species in different years in the same area. Other examples of range-size variation are discussed from the literature. These examples show that changing the size of the home range is one way that animals adapt to changes in the environment. They show also that changes in range size will affect census results, and may make it necessary to modify census methods.

METHODS

Trapping and marking.—Galvanized metal Sherman live traps of large size (3 × 3 × 9 inches) were used. They were baited with whole-kernel corn. A trace of peanut butter was placed on the door and the treadle the first day of each period. After each capture, all remaining corn was removed from the trap (and from the area) and replaced by fresh corn, because mice generally ate only the germ. No nesting material was provided. Traps were checked daily before 9:00 AM, then rechecked and set after all mice were released. Mice were marked with individually numbered metal ear tags and released where they were trapped.

Field procedures.—Traps were set 10–16 June, 23–29 June and 6–12 October 1954, when the mouse population was low. Trapping was repeated on these same dates in 1957, when mice were normally abundant.

In the first trapping period, 10–16 June 1954, traps were set approximately on a 60-foot grid. Each trap was set near the tree that was closest to the appropriate grid point. There were nine rows of nine traps each, enclosing

an area of about 5.3 acres. In this first period, most of the mice were trapped in the outer row of traps at least once. This suggested that the trapping area included only a part of the range of each mouse and that the trapping plot therefore was too small. Individual mice traveled far enough that it seemed likely that the traps were closer together than necessary. It seemed better to repeat the trapping on a larger grid than to estimate population densities or range sizes from data that obviously were inadequate.

In the second and third trapping periods, 23–29 June and 6–12 October 1954, traps were set approximately on a 110-foot grid. The plan was for nine rows of nine traps each, but the plot reached the river at the northeast corner so that there were only seven traps in the north row and there were irregularities in positions of some traps. This larger area was about 17.2 acres. It surrounded and enclosed the 60-foot grid. The small grid was not exactly in the center of the large grid, however. Trap IV-4 of the small grid was at the same position as trap G-10 of the large grid and the small plot therefore was in the east central part of the large plot (Fig. 1B). Irregular positions of the traps on the 60-foot grid and the off-center positions of the grids in relation to each other were the result of using points of reference established for other studies. More regular arrangements would have been better, but would not have affected the results perceptibly.

In 1957, the first two trapping periods were conducted as in 1954 so that results could be compared: 60-foot grid on 10–16 June and 110-foot grid on 23–29 June. Results of the 23–29 June trapping showed that the traps were too far apart and too few for reliable estimation of numbers of mice or their travels. The third trapping, 6–12 October 1957, therefore was done on the 60-foot grid instead of the 110-foot grid used for the third trapping in 1954.

Estimation of numbers and ranges.—Population density was estimated by a method used previously (Stickel, 1946, 1948). A border zone within the trapping plot was treated as a buffer area, and the population was estimated for the part of the plot central to the buffer strip. The population of the central plot was taken to consist of all mice trapped there plus one-half of the number of mice trapped both in the central plot and in the buffer strip. Mice trapped only in the buffer strip were not used in the calculations. The buffer strip was made more than half as wide as the average distance the mice traveled between traps. It was 165 feet wide for the 110-foot grid and 90 feet wide for the 60-foot grid, and so included the outer two rows of traps in each. These widths were arbitrary, but seemed to provide a buffer area large enough to be effective. This method of estimation is essentially a direct count and so assumes that all or nearly all resident mice are trapped. This was true in an earlier study of *Peromyscus* (Stickel, 1946), and probably was true in the present study, for very few unmarked mice were trapped after the fourth day.

Travels of individual mice were measured as the maximum known distance between traps. Data for mice caught only in the outer row of traps or caught

less than four times were excluded from the calculations. Comparisons of range sizes of mice in the two years were made for all trapping periods. The most appropriate comparisons were those between data of 23–29 June 1954 (110-foot grid) and 10–16 June 1957 (60-foot grid), as shown in Fig. 1B and 1C, because different spacings and plot sizes were needed for adequate data when the ranges and population densities were so different. Range distances measured for these periods probably were not much smaller than actual ranges (minimum range length as defined by Stickel, 1954), for average distances at successive captures increased only slowly after the first four captures. Statistical methods used for estimating standard errors and significance of differences are from Snedecor (1956).

RESULTS

Populations and ranges.—Trapping results, including estimates of population densities and travel distances, are summarized in Tables 1 and 2 and illustrated in Fig. 1.

The pertinent results were that the ranges of male *Peromyscus* were larger when the population density was lower and smaller when the population density was higher. When the population density was about 1.3 male mice per acre, 23–29 June 1954, the average distance recorded between traps after four or more captures was 258 feet. When the population density was about 4.1 male mice per acre, 10–16 June 1957, the average distance was 119 feet. Differences in the two years were statistically significant (t-test; $P<0.001$). Comparisons of travel distances recorded in other contrasting periods of 1954 and 1957 also showed significant differences ($P<0.001$ in each test). Periods compared were: 10–16 June 1954 vs. 10–16 June 1957; 23–29 June 1954 vs. 23–29 June 1957; 6–12 October 1954 vs. 6–12 October 1957. Very few female

TABLE 1.—*Male Peromyscus: numbers of mice and distances between capture sites*

	1954			1957		
	June 10–16	June 23–29	Oct. 6–12	June 10–16	June 23–29	Oct. 6–12
Trap spacing	60 ft.	110 ft.	110 ft.	60 ft.	110 ft.	60 ft.
Size of area	5.3 A	17.2 A	17.2 A	5.3 A	17.2 A	5.3 A
Number trapped	8	29	19	35	81	36
Estimated per acre population	—	1.3	0.4	4.1	—	4.1
Number trapped exclusive of outer row	4	16	7	23	53	20
Number of preceding trapped 4–7 times	4	13	6	19	28	19
Distance (feet)	130 to 248	108 to 576	160 to 411	46 to 207	93 to 141*	42 to 298
Average distance	207	258	281	119	105	113
Standard error of mean	27	40	12	3	18	13

* For 10 mice that visited more than one trap. In addition to these, one young adult male traveled 609 feet diagonally across the plot.

mice were trapped in 1954 and their travel records were too few for reliable comparisons with 1957. The basic data are shown in Table 2.

In 1954, the population declined from 1.3 males per acre in June to 0.4 males per acre in October. The average travel distance was somewhat greater in October, but the difference was not statistically significant. Travel distances in the different periods in 1957 were closely similar to each other.

Survival of male *Peromyscus* in the trapped plots from June to October was about the same in each year. In 1954, 12 of 28 (43%) males (juveniles excluded) released on the large plot in June were retaken on the same plot in October. In 1957, 14 of 35 (40%) males released on the small plot in June were retaken on the same plot in October. Survival data for females were inconclusive because of small numbers. In 1954, 1 of 4 (25%) females (juveniles excluded) released in June was retaken in October. In 1957, 13 of 20 (65%) released in June were retaken in October. Differences in the two years were not significant (Chi-square test).

Effects of trap spacing and plot size.—Parts of Fig. 1 illustrate the results to be expected when a trapping plot is too small or trap spacing too great.

(1) Figure 1A shows results 10–16 June 1954 when the mouse population was low and the 5.3-acre plot was too small to include the complete ranges of the mice. When the larger plot was trapped a week later, all of the mice were caught in traps beyond the borders of the original plot. The small size of the original plot was the principal limitation on the amount of travel that could be recorded. Travels recorded in the second period probably were somewhat greater also because the traps were farther apart, for differences in travels recorded at different trap spacings result mechanically even when traps are visited at random (Stickel, 1954).

(2) Figure 1D shows results 23–29 June 1957 when the population was

TABLE 2.—*Female Peromyscus: numbers of mice and distances between capture sites*

	1954			1957		
	June 10–16	June 23–29	Oct. 6–12	June 10–16	June 23–29	Oct. 6–12
Trap spacing	60 ft.	110 ft.	110 ft.	60 ft.	110 ft.	60 ft.
Size of area	5.3 A	17.2 A	17.2 A	5.3 A	17.2 A	5.3 A
Number trapped	4	12	8	20	49	30
Estimated per acre population	—	0.6	0.4	2.4	—	3.1
Number trapped exclusive of outer row	3	6	4	13	28	15
Number of preceding trapped 4–7 times	1	0	2	10	12	14
Distances (feet)	312	—	117, 148	0, 51–162	108, 111, 114, 154*	0, 0, 52–147
Average distance	—	—	—	104.3	—	99.6
Standard error of mean	—	—	—	13	—	8

* Only 4 mice visited more than one trap.

high and traps set at 110-foot intervals were too far apart and too few. The fault was shown in two ways: First, only 28 of the 53 males caught in the inner rows of traps were caught as often as four times. In all other trapping periods, in contrast, nearly all the mice in the inner rows were caught at least four times apiece (Table 1). Second, only 11 of these 28 were caught in more

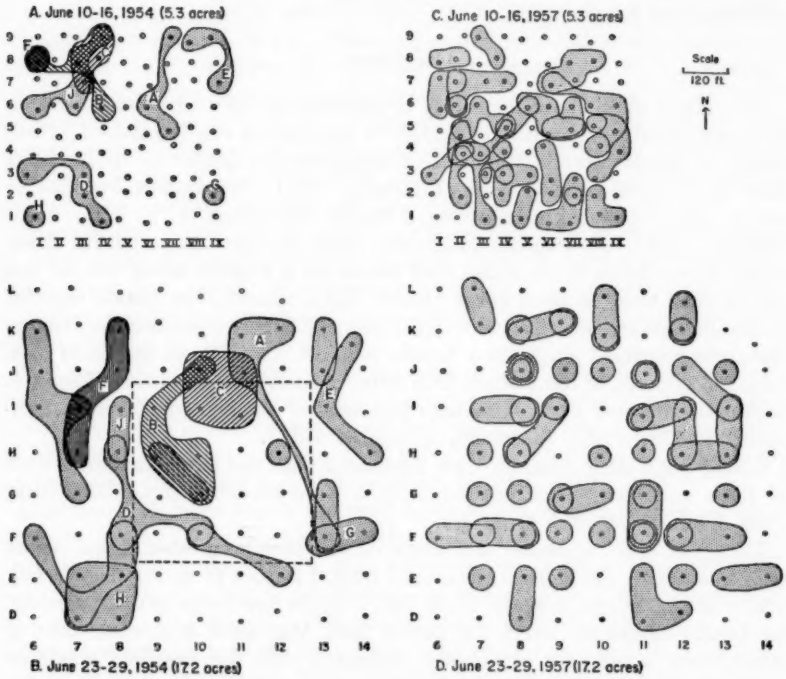

FIG. 1.—Capture sites of male *Peromyscus leucopus*, showing range differences at times of low and high populations, and showing also the effects of different plot sizes and trap spacing. Records of individuals are enclosed by solid lines only as an aid to the eye. The lines are not intended to represent range boundaries.

A. Capture sites of all eight adult and subadult mice and the one juvenile caught 10–16 June 1954. Letters indicate individuals. The one marked *J* is the juvenile. All mice were caught at least once in the outer trap row, which suggested that they ranged beyond the plot and that the plot therefore was too small.

B. Capture sites of 16 adult and subadult mice trapped 23–29 June 1954. Mice trapped only in the outer row of traps are not shown. Letters indicate the same individuals shown in A. Position of the smaller plot is outlined.

C. Capture sites of 23 adult and subadult mice trapped 10–16 June 1957. Mice trapped only in the outer row of traps are not shown.

D. Capture sites of 52 adult and subadult mice trapped 23–29 June 1957. Records are not shown for one young adult male who traveled across the plot from E-11 to I-7. Mice trapped only in the outer row of traps are not shown. Scarcity of travels between traps showed that the traps were too far apart for reliable estimation of populations or ranges, and that traps probably also were too few.

than one trap. The other 17 were caught in the same trap each time. The fact that there were so few traps probably prevented mice from visiting as many different traps as they might have. Scarcity of traps apparently also prevented capture of some mice. For, although 30 of the 35 mice trapped on the 60-foot grid 10–16 June were caught again on the 110-foot grid 23–29 June, three mice skipped this second period but were caught again in October; two were not caught again.

DISCUSSION

The ranges of small mammals may be different in different habitats. *Microtus pennsylvanicus* ranged more widely in dry than in moist grassland (Blair, 1940). In another area in Michigan, *Microtus* traveled farther in stubble fields than in fields of shocked corn (Linduska, 1942). *Peromyscus leucopus* in young upland pine-oak woods ranged farther than those in the bottomlands (Stickel, 1948). *Peromyscus polionotus* living in the comparatively dense cover of the dunes fronting the Gulf Beach on a Florida island ranged less widely than those in open cover (Blair, 1951). *Blarina brevicauda* traveled farther in a grassy field than in woods (New, 1958). *Tamiasciurus hudsonicus* had more restricted ranges in a heavily wooded area than in the more open park-like grounds of the Cornell University campus (Layne, 1954). *Zapus h. hudsonius* at Itasca Park, Minnesota had smaller ranges than *Zapus h. campestris* at Centerville, Minnesota (Quimby, 1951).

Lower population densities were associated with the larger ranges in each of these examples where population data were readily comparable (Blair, 1940; Linduska, Stickel, Quimby).

Ranges of small mammals in a single habitat may be greater at one season than at another. *Peromyscus polionotus* ranged farther in spring than in fall-winter in each of two habitats (Blair, 1951). Male *Apodemus sylvaticus* moved far greater distances during the period from May until September than at other times, a behavior apparently correlated with the breeding condition of the females (Miller, 1958).

Differences in travels in the same area in different years may be associated with both food supply and population density. *Peromyscus gossypinus* in a hardwood forest in Florida had smaller ranges under crowded than uncrowded conditions. The high population was attributed to an abundance of acorns (Pearson, 1953). In an experimental study of *Peromyscus leucopus* in which food was supplied in excess to an island population, travels were more restricted when the population became denser (Bendell, 1959). In Bendell's study, increased population density rather than food apparently was the immediate factor in reducing travel distances. Food was supplied in excess continuously, but travels were not reduced until the population density had increased.

In contrast, *Tamiasciurus* on the Cornell University campus had larger ranges in 1953 when the population was high than in 1952 when the popula-

tion was lower. The differences in range were attributed to a greater abundance of elm seeds in 1952 (Layne, 1954).

In the present study, the greater range sizes were associated with smaller populations. The reason for the low population density may have been lack of food, but this is not certain. Mast was relatively scarce in 1953, but no objective measurement of the crop was made. *Peromyscus* populations were at least as low in the same area in 1944: 100 live traps on 2.5 acres caught only one *Peromyscus* 18–24 June 1944; they caught one adult and two juveniles on the area 11–15 July 1944. In another bottomlands plot, 100 live traps on 2.5 acres caught one *Peromyscus* 26 September–3 October. One hundred live traps on a ⅝-acre area caught one mouse 20–25 September 1944 and 100 live traps on another ⅝-acre plot caught no *Peromyscus* during the same period. Population density in 1945, 1946, 1948 and 1949 was approximately as high as in 1957. Data are not available for other years.

To summarize: Home-range size of a species may vary widely in response to many different factors, including habitat, breeding condition, population density, and food supply. Large ranges most often are reported when the population density is lower, but this is not always true. Larger ranges usually are associated with food scarcity.

The possibility of variation in home-range size should be considered in interpreting the results of a small-mammal census, a fact that was emphasized by Komarek (1937). In a comparison of line-trapping in two different habitats, differences in range sizes changed the effective sampling areas of the lines and so biased the results to a serious extent (Stickel, 1948).

Differences in range size in the same habitat from year to year could have the same effect on periodic samples from a single area. It is not satisfactory to convert trap-line data to per acre figures by using home-range estimates from other places or times, for changes in range size could introduce significant error. The examples from field studies show that significant variations in range occur, not only from place to place, but also from time to time, and apparently in response to different factors. It is unlikely that major population differences would be missed in any systematic trapping on a large enough scale, either by trap lines or scattered traps. Reliability of experimental studies or other studies where small differences must be measured could be seriously affected.

Variation in range size also can affect the results of grid-trapping, as discussed above and shown in Fig. 1. A trapping area that at one time may be large enough to enclose the ranges of several mice, at another time may not be large enough to completely enclose the range of any one individual. The trapping area is too small if most mice are caught in the outer row of traps. If, however, most mice are caught in a single trap apiece, trap-spacing is too great or traps are too few. Then, all the mice probably will not be caught. A standard trapping plan cannot be followed routinely, even in the same area and for the same species. In grid-trapping, a map of capture sites will show

what adjustments are necessary, and procedures can be changed. In line-trapping, and particularly in kill-trapping, range changes that will affect the results may go undetected.

SUMMARY

Live-trapping studies at the Patuxent Wildlife Research Center, Maryland, showed that the ranges of wood mice were larger when the population density was lower and smaller when the population density was higher. When the population density was about 1.3 male mice per acre in June 1954, the average distance recorded betweeen traps after four or more captures was 258 feet. When the population density was about 4.1 male mice per acre in June 1957, the average distance was 119 feet. Differences were statistically significant. Females were so scarce at the low that comparisons could not be made for them. Examples from the literature also show that home range of a species may vary with population density. Other examples show that the range may vary with habitat, breeding condition and food supply.

These variations in range size reduce the reliability of censuses in which relative methods are used: Lines of traps sample the population of a larger area when ranges are large than they do when ranges are small. Direct comparisons therefore will err in some degree. Error may be introduced also when line-trap data are transformed to per acre figures on the basis of home-range estimates made by area-trapping at another place or time. Variation in range size also can make it necessary to change area-trapping plans, for larger quadrats are needed when ranges are larger. It my be necessary to set traps closer together when ranges are small than when ranges are large.

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Patuxent Wildlife Research Center, Laurel, Maryland. Received 30 December 1959.

THE POUCH YOUNG OF THE POTOROO

BY ERIC R. GUILER

The potoroo, *Potorous tridactylus* (Kerr), is one of the lesser-known Australian marsupials. Formerly found in Victoria and New South Wales, as well as probably in South Australia, it is now rare on the mainland of Australia, the only recent records being in 1913 and 1958 (Marlow, 1958). The Tasmanian subspecies is still very common and some investigations have been carried out on the biology of the species (Guiler, 1958*a*, *b*).

There are no detailed descriptions of the sequence of development of the various structures in the pouch young of *Potorous*, although this topic has been studied in another Australian marsupial, *Trichosurus vulpecula* (Lyne and Verhagen, 1957) and some growth measurements for the American *Didelphis marsupialis* were given by Hartman (1928) and by Reynolds (1952). The potoroo, which belongs to the family Macropodidae, is not closely related either to *Trichosurus* or *Didelphis*. This paper contains the first detailed description of the post-natal development of a macropod marsupial.

The adult female potoroo weighs about 1350 grams and is brown in color, grizzled with gray. The head and body length is about 450 mm. and the tail measures another 250 mm. The form of the body is typically macropod (Plate I) but the hind legs do not reach the same development as in the kangaroos. The tail is rat-like, and may bear a white tip. A full description of this little-known marsupial is in preparation and will be published later.

The observations quoted below were made upon a laboratory population of potoroos which were established to help interpret incomplete data obtained from field observations. A total of seven juveniles were raised from birth under laboratory conditions and other observations were made on 26 preserved specimens and 52 live pouch young observed in the wild state. Some of the wild animals were examined several times.

The measurements were made following the standard measurements of Jones (1923).

The age of pouch young has been standardized by measurement of young whose day of birth was known. It was found that the various measurements in newborn young may differ by as much as 20 per cent and this discrepancy must lead to some inaccuracy in the determination of the age of any given specimen. Added to this, the age at which the structures develop also varies from specimen to specimen. For this reason a plus-or-minus dating is given below. The most accurate measurement is the length of hind foot, except in very young animals when the forelimb measurement should be used.

THE POUCH YOUNG

Parturition has not been witnessed by the author but the presence of young in the pouch has been noticed within 12 hours of birth. The young at birth varies in C.R. length from 1.47 to 1.61 cm. with a total length of the hind limb of 0.47–0.58 cm. At this stage the forelimb (0.63 cm.) is larger than the hind limb and is much more developed. There are well-developed horn-colored claws on the forelimb and these are used for the progression to the pouch. By comparison, the hind foot is but poorly developed and capable of only limited feeble movements. There are no claws on the hind foot and the toes appear only as buds. The young animal is capable of very active movements for such a small organism but it is particularly notable that the strength

PLATE I

Adult female *Potorous tridactylus* (back to camera) with juvenile female young. Note the typical macropod stance of the young.

of the movements is in the arms and forequarters. Considerable relative strength is exerted in grasping movements.

The newborn young is a scarlet color and the subcutaneous blood vessels can be seen clearly below the surface of the skin. The ears can be barely distinguished as irregularities on either side of the head and the eyes are present as subcutaneous black pigmented spots.

The neonatal young is capable of living for several hours devoid of any source of food or warmth.

On entering the pouch the young immediately attaches itself to a nipple. In multiparous mothers, the nipples used by the previous young are still distended and may even be longer (3.0 cm.) than the neo-natal young, and thus too large for the newborn young to seize in its mouth, so another nipple is selected. Figure 1 shows that the nipple used is usually situated anti-clockwise from that previously occupied. The nipple may adjoin or be once removed from that previously used. In animals 1, 3, 6, 7, 8, 12, 15, 16, and 17 the rotation could well be clockwise or anti-clockwise, past two vacant nipples. Animal 5 had only three nipples, one having been bitten off.

Hair.—There are a few downy hairs on the dorsal surface of the body which become obvious at day 82 ± 4. These do not develop as body hairs and are foetal in nature.

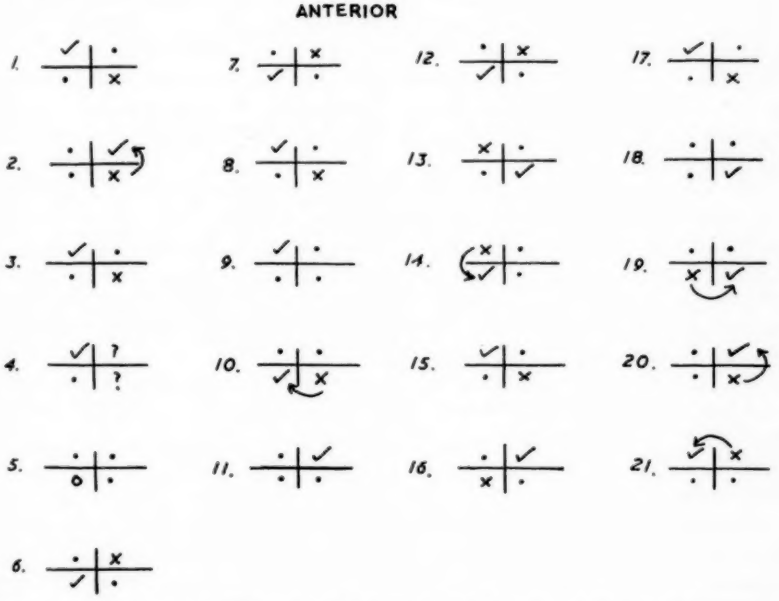

FIG. 1.—Nipple use in 21 females of *Potorous tridactylus*. In this figure a tick represents the nipple in use and a cross shows the nipple previously used.

The eruption of the juvenile hair is preceded by a darkening in color of the general body surface. Darkening commences at the rhinarium and at the back of the neck on day 90 ± 4, though 5 days previous to this there is a slight general darkening of the whole dorsal surface. However, the first rapid development of dark pigment takes place when the pouch young is 92 ± 4 days old, the eyes being firmly shut at this time. By day 94 ± 4 the dark areas spread 0.85 cm. up the snout, the rhinarium measuring 0.46 cm., i.e., the dark area extended 0.39 cm. beyond the rhinarium. This area does not extend down the sides of the snout.

Fur appears first on day 97 ± 5, being found on the inner surface of the ears as well as on either side of the median digit of the hind foot. The rest of the body is hairless or possesses a fine colorless downy fur. Meanwhile, the dark color spreads and deepens, until by day 102 ± 5 the whole dorsal surface, but not the sides or ventral surface, is a charcoal color. By this time, the inside and outside of the ears are furred and the eyes are open for the first time. However, apart from the ears and hind feet, there is still no body fur visible.

The dark color deepens to a very dark gray and continues to spread down the flanks and below the jaws but by day 105 ± 5 this color still has not reached the ventral surface. At that age there is fur between all the fore and hind toes. The first part of the general body surface to grow fur is the chin at day 106 ± 5, but the general body surface does not grow fur until 5 days later when fur appears simultaneously over most of the body, the exceptions being the top of the head and the ventral surface which is still pink and naked. Previous to this eruption (on day 109 ± 5) the body becomes a deep blue-gray color, including the snout and limbs but not the ventral surface.

The hair on the dorsal surface on day 113 ± 5 is black in color, although the ventral surface is naked and unpigmented. By day 116 ± 5 the body, including the ventral surface, is completely furred with soft underfur of a black to very dark blue color, though the undersurfaces of the body are covered by hairs of a lighter color. There are brown-colored hairs appearing through the dark underfur. At this stage, the animal can first make feeble hopping movements.

The young animals gradually assume the dark brown subadult coloring, with softer fur than that of adults. This color persists for about two years, during which time the adult color of dark brown flecked with gray is gradually assumed, the first gray flecks appearing during the young animal's first winter.

The eyes.—At birth the eyes are barely distinguishable as two subcutaneous black pigmented areas. The eyes develop below the skin and form large bulbous structures at about 30 ± 2 days of age. The eye slits can be distinguished at this age but the eyes are not open. The lower lid develops a covering of heavy down at about 85 ± 4 days of age.

The eyes open before the body becomes fully furred, but the age at opening varies from 90 ± 5 to 98 ± 5 days. Both eyes may open at the same time or there may be up to 4 days' difference in the time of opening. One female was observed to have difficulty in opening the anterior portion of the left eye.

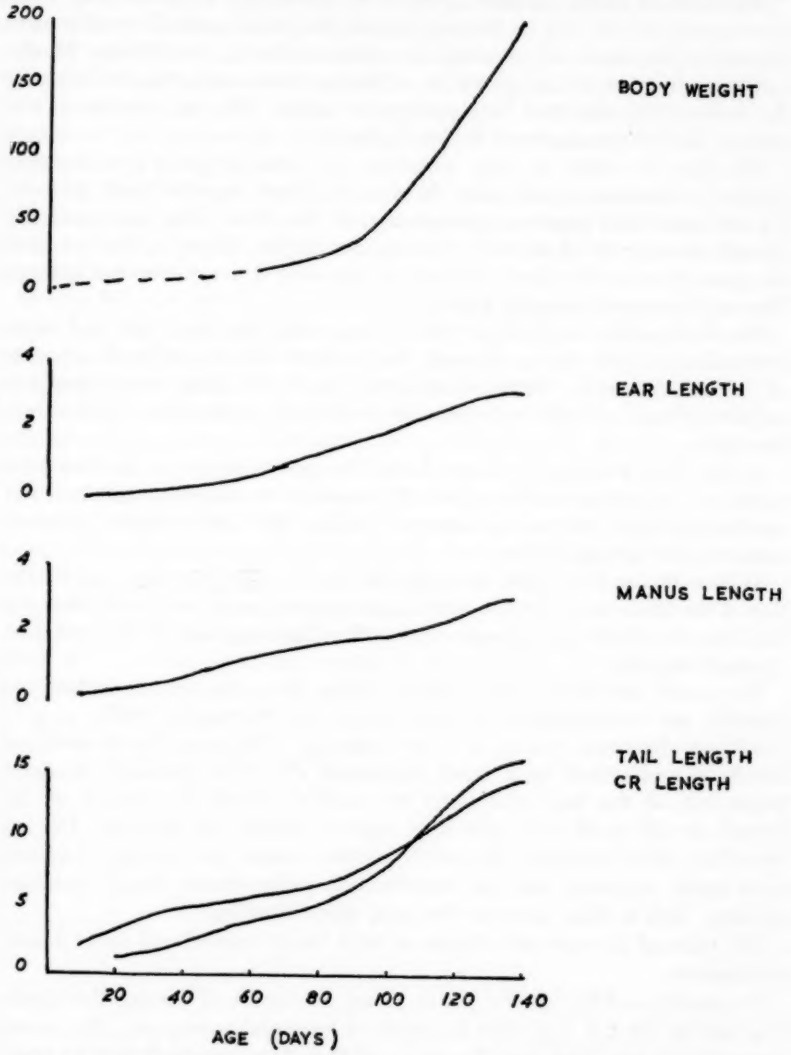

FIG. 2.—Growth curves for pouch young of *Potorous tridactylus*. The measurements in these curves are in cm.

The ears.—The ears can be barely distinguished at birth, being only slight irregularities on either side of the head. At day 10 a slit appears on either side of the head but a low fold to the rear of this slit is all that can be seen of the external pinna.

The external pinna becomes apparent at about day 12 after birth, when it measures 0.16 cm. On its first appearance the pinna points forward toward the end of the snout, i.e., covering the orifice of the ear, but by day 24, size 0.39 cm., the external ear points in a dorso-posterior direction, folding over the back of the head and so exposing the orifice. The ear remains in this position for the remainder of its development.

The ears are white in color whenever the external pinna first becomes apparent. However, shortly after the ears fold back over the head, at about 0.6 cm. size, dark pigment appears around the distal edge and gradually spreads to cover all of the ear. There is no further change in the ear until the pinna becomes free from the head at day 80 ± 4, i.e., before fur appears. The ear then soon becomes furred.

The limbs.—The forelimb at birth is longer than the hind limb and bears five well-developed claws, although the humeral, radial and hand segments of the limb cannot be distinguished at this stage. The hind limb is similarly undifferentiated at birth but there are only three feeble buds representing the digits.

At day 7 the hind limb, measured from the posterior end of the knee joint to the toe, is approximately equal to the length of the forelimb and from this age the hind limb becomes progressively larger than the forelimb, gradually assuming the macropod form.

At day 10 the hind limb develops the fourth digit. At this period, the toes of the hind limbs have become more separated and developed from the bud form in which they appeared at birth. Claws appear on the hind foot at about day 30.

The pouch and testes.—The potoroo differs from the possum in that the genitalia are distinguishable at birth (Lyne and Verhagen, 1957), so it is possible to determine the sex at a very early age. The pouch in the newborn female is represented by a small abdominal slit. This gradually becomes larger but, at the time of leaving the mother's pouch, the pouch of the juvenile is still small with very tight muscles closing the entrance. On approaching sexual maturity, the pouch becomes larger, the entrance becomes more easily distended and the characteristic yellow-brown pouch secretion appears. This is often preceded by some slight bleeding.

The testes of the male are obvious at birth, being external and about 3 mm. in diameter.

Locomotion.—Although the pouch young is capable of leaving the nipple at about day 55 ± 2, it is quite incapable of terrestrial movement. The young can make its way back into the pouch at this stage, provided that its head is inserted into the aperture. It may be possible for it to find the entrance

unaided but this would be a matter of trial and error and might not be successful.

At day 87 ± 4 (weight 35 gm., hind foot length 3.25 cm.), the pouch young can make poorly coordinated movements but every attempt to walk is frustrated by a poor sense of balance, the animal falling on its side. Pads develop on the plantar surface of the hind foot by day 86 ± 4.

By 90 ± 4 the coordination improves sufficiently for the animal to stand up without tumbling over, though it is still incapable of movement. The eyes are closed when the animal is at this stage. The full development of the sense of balance and the power of controlled movement is associated with the opening of the eyes.

By day 105 ± 5, when the eyes are open, the young can stand with ease, move its ears and move backward for a few centimeters without losing balance. However, all movement is backward and no attempt is made by the animal to move forward.

At day 107 ± 5 (81.7 gm., C.R. 10.28 cm.) the young can move forward with a walking action and turn round. The animals crawl freely over the mother seeking the pouch but still search for the aperture by trial and error, investigating the dorsal surface as well as the ventral. Once the snout is inserted into the aperture, a couple of strong pushes by the hind legs together with pulls from the forelimbs and the animal quickly enters the pouch.

By day 109 ± 5, the coordination has improved to such an extent that balancing on three legs while scenting is achieved. The most rapid development of locomotor powers took place at this period when the body was almost completely furred. By day 112 ± 5, a poor hopping gait was achieved and 2 days later both walking and hopping were possible.

On day 116 ± 6, the young can rapidly enter the pouch unaided. It is likely that by this stage the youngster spends part of the night out of the pouch.

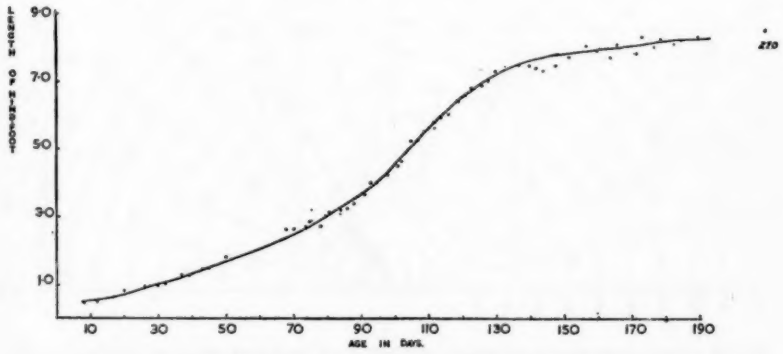

FIG. 3.—Growth of hind foot of *Potorous tridactylus*.

At day 120 ± 6, the young, by now fully furred in the juvenile dark-colored hair, can hop in typical potoroo fashion, holding the forelegs clear of the ground, and can move rapidly and effectively in a straight line.

The tail.—The tail at birth measures approximately 0.52 cm. in length. It is nonprehensile at this stage. However, later in development, from about day 80 ± 4 almost until the time of leaving the pouch, the end of the tail becomes partially prehensile and can be wrapped around objects. The animal can almost support its own weight by this means. The adult animal loses this faculty.

The senses.—The eyes open at about 90–98 days (see above). It is doubtful if vision is achieved until some time after the eyes open. A reaction to tests in the form of a withdrawal or movement of the head did not take place until 14 days after the eyes were open, at day 112 ± 3.

The sense of smell is well developed in comparison to vision in the earlier stages. For several days before the eyes open the animal scents the air when removed from the pouch. As soon as the youngster can move it can locate the scent of the mother at a distance of 2 feet, and make its way toward her.

Correlated with the well-developed sense of smell, the rhinarium first becomes distinct at 26 days. It grows rapidly and two days later it is well developed, bearing black pigment. However, it is not until 87 ± 4 days (30 gm. weight, hind foot length 2.75 cm.) that the rhinarium assumes the wrinkled surface typical of the adult.

The sense of balance does not become fully efficient until the eyes have been open for about 6 days. Prior to eye opening, any attempt to move is frustrated by falling over, because the sense of balance is at fault.

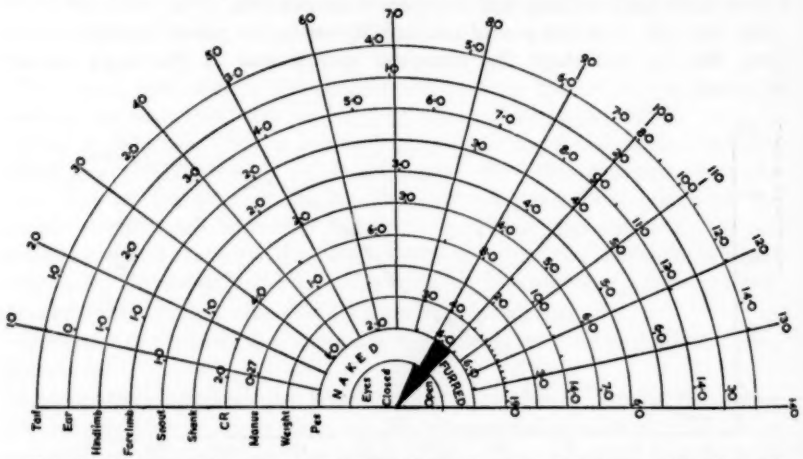

FIG. 4.—Nomogram for age determination of pouch young of *Potorous tridactylus*. The age in days is given on the radii of the circle.

The nostrils.—Nostrils are visible as ill-defined unopened slits in the newborn young. The nostrils remain closed for about the first 25–30 days.

Teeth.—The young does not possess teeth, but holds on to the nipple with its lips. This is aided by the end of the nipple becoming dilated and more or less filling the cavity of the mouth.

The lower incisor teeth are the first to appear and do so before any fur is apparent on the surface of the animal. These teeth erupt at day 90 ± 4. For some time previous to the appearance of the teeth, the young has been able to relax its hold upon the nipple and regain its grip unaided.

The upper incisors erupt at about 95-100 days, at approximately the same time as the dark coloration of the body spreads extensively from the head. There is some variation in the time of eruption of the teeth but the upper incisors always appear before the premolars and molars which may not appear until day 102 or later. The first premolars erupt before the remaining teeth but these teeth appear in a continuing series. At the time of eruption of the upper incisors, the premolars and molars appear as white irregularities on the gums.

The facial vibrissae.—The papillæ of the various vibrissae appear at about 25 days. However, the vibrissae themselves do not erupt for another 25 days. The anal, mystacial, supraorbital, genal, interramal and ulnar-carpal vibrissae all appear at approximately the same time, the mystacials being the first.

Growth.—Growth curves for various parts of the body were constructed from the data gained from the experimental animals. The measurements were made at regular intervals of 3 days throughout the pouch life of the seven young potoroos. The growth curves are shown in Figs. 2 and 3. These curves are sigmoid and are similar in form to those found in the brush possum by Lyne and Verhagen (*op. cit.*). The body weight of very young potoroos is not known for they are attached firmly to the nipples. For this reason, the lower part of the curve is shown as a broken line. The body weight is highly

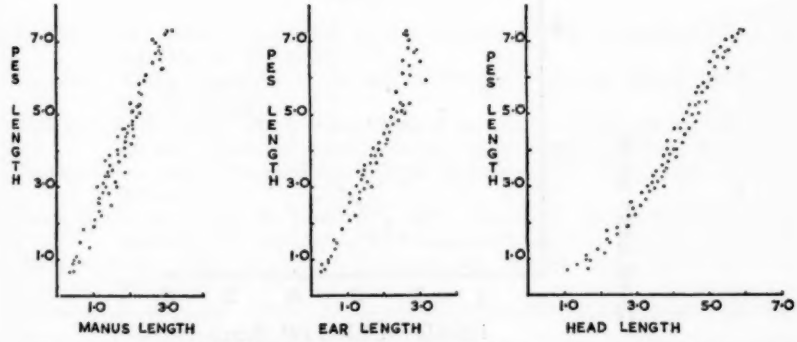

FIG. 5.—Relation of the length of the pes to that of the manus, ear and head in *Potorous tridactylus.*

variable and two young of the same size or age may differ considerably in weight. For this reason, weight is of little value in age determination.

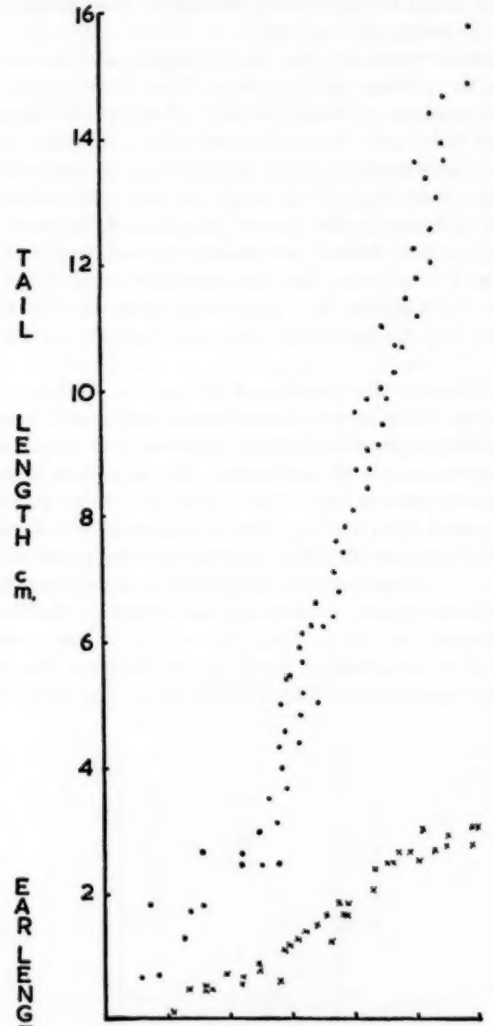

FIG. 6.—Relation of head length to the length of the tail and ear in *Potorous tridactylus*.

The tail becomes larger than the C.R. length at approximately 110 days of age. The growth of the hind foot slows down very much at about 130 days and after 170 days the length of the foot increases very slowly and at this time this measurement ceases to be of value as an age indicator.

The data obtained from the measurement of the pouch young were used to construct the nomogram shown in Fig. 4. This can be used to obtain the full measurements and age of a specimen from any one given measurement of the specimen. The accuracy to be expected from the use of this diagram is ± 3.5 days (see earlier).

The growth of certain parts of the body in relation to other structures is shown in Figs. 5 and 6. Comparison of these graphs with those of Lyne and Verhagen shows that a sigmoid relationship exists between the growth of the same structures in both species. These structures are the ear in relation to the head and the pes in relation to the head.

The results obtained from the laboratory colony of animals were complemented by measurements made upon preserved pouch young. These were further supplemented by irregular observations on the living pouch young of wild mothers. The data obtained from the wild animals fit closely to those from the captive colony. This result parallels that obtained by Lyne and Verhagen (1957) on the brush possum.

SUMMARY

The post-natal development of the pouch young of *Potorous* is described and a nomogram is given showing the sizes of various structures in relation to age. The forelimbs are larger than the hind limbs at birth but by day 7 the hind limbs become larger and gradually assume the adult macropod form.

Graphs of the growth of the limbs are given and these follow a sigmoid form, as do graphs of the relationship of the growth of the head to the ear and pes, respectively.

Data obtained from wild animals differed very little from those obtained from the captive population.

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EVAPORATIVE WATER LOSSES OF THE PALLID BAT

By Robert M. Chew and Harold E. White

Little is known of the water metabolism of bats, beyond the fact that many species come to open water to drink. This is in spite of the fact that bats have certain points of particular interest with regard to water exchanges: (1) their tremendous surface area relative to body weight offers a potentially large evaporative surface; (2) certain species are characteristic of arid environments; (3) the extended wing surfaces are fanned continuously when the rectal temperature rises beyond a certain point (Reeder and Cowles, 1951; Robinson and Morrison, 1957), possibly providing evaporative cooling; (4) the drinking of sea water by several species of *Myotis* (Dalquest, 1948) suggests that these bats can form urine more concentrated than sea water.

The purpose of the present study was to measure the evaporative water loss of *Antrozous pallidus*, which is considered to be a desert bat, under two conditions: (1) resting with wings folded, (2) semiactive, with wings extended. It was expected that this comparison would give a measure of the water loss from the extensive flight membrane surfaces.

Preparation of the manuscript was facilitated by a grant from the National Science Foundation, G-5570.

MATERIALS AND METHODS

A group of pallid bats was captured in early July 1955 in a barn on the San Joaquin Experimental Range, California. The bats were then kept at room temperature in Los Angeles through August, being housed individually in large battery jars. The bats quickly learned to eat meal worms and take water from drinking tubes. Their body weights remained normal in captivity.

Respiratory exchanges and evaporative water loss were measured in a Haldane open-circuit system, by the standard method described in Brody (1945). The animal chamber of the circuit was a plexiglass chamber just large enough to accommodate the wingspread of *A. pallidus*. During folded wing experiments the individual bat was allowed to hang up on a wire screen inside the chamber; for extended-wing experiments the bat was tied to the screen in an extended position, being securely fastened at finger tips and ankles, and restrained by a loose loop around the throat. The bats were kept without food for 20–26 hours prior to an experiment, and were thus postabsorptive during the measurements.

An airflow of 250 cc./min. was used in most experiments. Dry air, free of carbon dioxide, was drawn into the bat chamber, and the carbon dioxide and water vapor lost by the bat were absorbed in chemical absorbers (Ascarite and Dehydrite, respectively) as air was drawn from the chamber. Water vapor and carbon dioxide were measured hourly for 6 to 8 hours by weighing alternate sets of absorption tubes to 0.1 mg. Oxygen consumption for the entire experimental period was calculated from the weight changes of the components of the circuit, i.e., mg. O_2 = (Δ wt. of bat and chamber) +

(mg. CO_2 absorbed) – (mg. H_2O absorbed). Because the relatively heavy bat chamber could be weighed with less accuracy than the absorption tubes (±10 mg. versus ±0.5 mg.), the oxygen estimate is much less reliable than the directly measured CO_2 and H_2O. The estimates of oxygen consumption indicated an R.Q. of 0.7, which is to be expected in mammals long in a post-absorptive state. For purposes of making certain comparisons of the present data with previously published data, hourly oxygen consumptions were calculated from the directly measured CO_2 production, assuming the indicated R.Q. of 0.7. Any error involved in this calculation will be in the direction of too great an estimate of the oxygen consumption.

Since plexiglass loses a significant amount of water vapor to dry air, it was necessary to correct the total water absorbed for that lost from the chamber in order to determine the amount evaporated from the bat. This correction was determined in blank runs with no bat in the animal chamber.

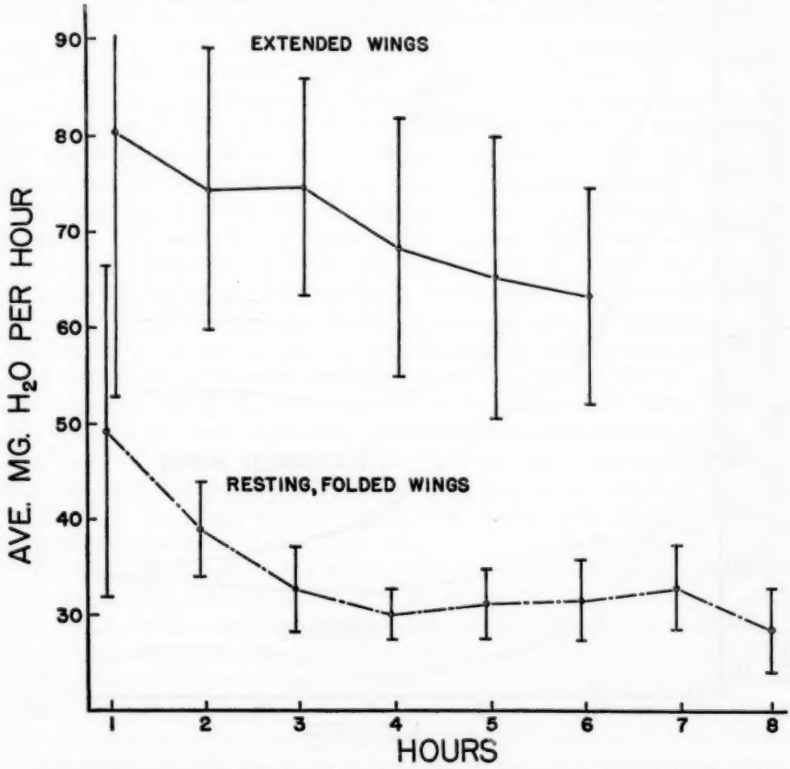

FIG. 1.—Hourly evaporative water loss of pallid bats during a 6–8 hour experiment at 25–27°C. and 9–27% r.h.; same individuals with wings folded and wings extended. Each plotted point is an average for 5 individuals; vertical lines represent one standard deviation.

Measurements were made on five bats. Folded-wing experiments were performed first, followed 6 to 7 days later by measurements on the same bats with their wings extended. Repeat measurements were made on two bats while resting with wings folded, 6 days after the extended-wing measurements.

The bats had an average weight of 15.8 (13.9–18.6) gm. at times of experiments. Flight surfaces, as measured from photographs of animals held with membranes extended over graph paper, ranged from 15.6 to 20.3 cm.^{2}/gm. body weight, or 283 cm.^{2} for an average sized bat. The head and trunk are estimated to have an additional 63.5 cm.^{2} of surface area.

Air temperature in the chamber during measurements averaged 26°C. (25–27°) and relative humidity ranged from 9 to 27 per cent.

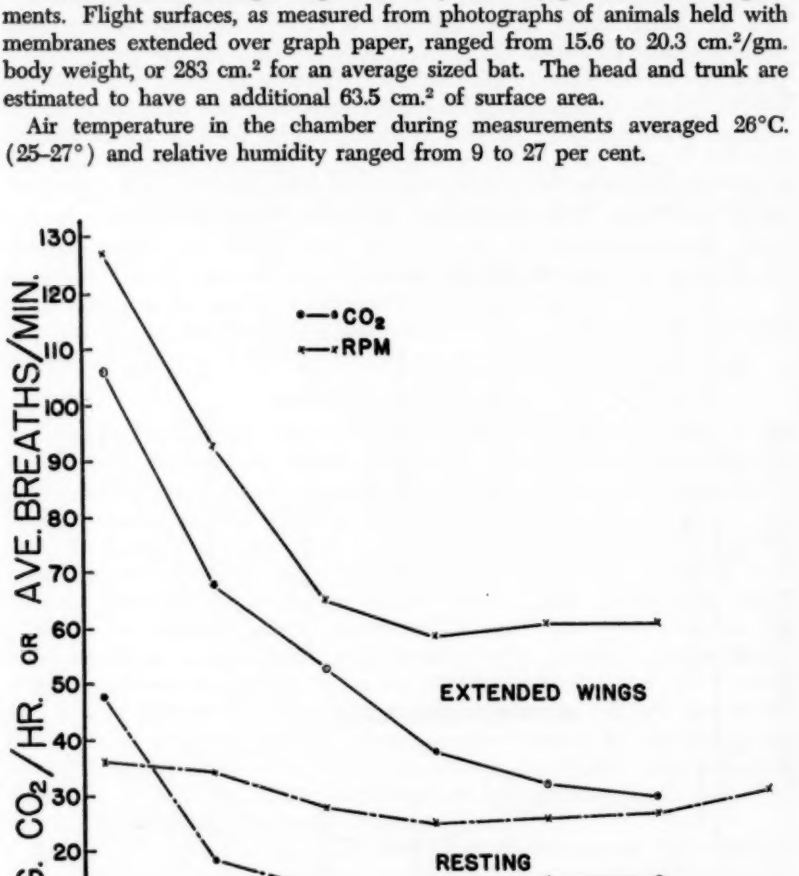

FIG. 2.—Hourly carbon dioxide production and breathing rates of pallid bats during a 6–7 hour experiment at 25–27°C. and 9–27% r.h.; same individuals with wings extended and resting with wings folded. Each plotted point is the average for 5 individuals.

RESULTS AND DISCUSSION

Water loss.—Figure 1 shows the average water loss per hour during the 6 to 8 hours duration of the measurements. There is a highly significant difference between the water losses of the bats when their wings are extended and when they are folded (except during the first hour when variation among individuals is excessive). The bats lost more than twice as much water when their wings were extended as when they were hung up with folded wings.

The difference in rate of water loss is apparently due to the different metabolic rates in these two situations, rather than to the large difference in amount of exposed surface area. As shown in Fig. 2, trends in carbon dioxide production and breathing rate grossly parallel that of water loss, and the average minimum hourly carbon dioxide production of extended-wing bats is about three times that of folded-wing bats. As shown in Fig. 3, the data indicate a linear relationship between the rate of metabolism and water loss in the extended-wing experiments, in which the range of values was greatest. Water loss showed a highly significant regression on hourly carbon dioxide production: mg. $H_2O = 54.8 + 0.303$ mg. CO_2.

An increase in metabolism obviously involves a greater respiratory volume and an increased loss of water from the respiratory surfaces in saturating the air that is expired. Water loss by diffusion through the skin may also be directly related to metabolism, as is true for *Peromyscus* (Chew, 1951).

In the present work the skin and respiratory water losses were not measured separately. However, if it is assumed that inspired oxygen was utilized with 12 per cent efficiency, and that air was inspired at 18 per cent relative humidity and 26°C. (4.8 gm. H_2O/m^3), and expired at 100 per cent relative humidity and 26°C. (24.5 gm. H_2O/m^3), then the average respiratory water loss would be 7.1 mg./hr./bat for the folded-wing animals during the third to seventh hours of the measurements, and 19.0 mg./hr./bat for the extended-wing animals during the fourth to sixth hours. Respiratory losses are then 22.4 and 28.9 per cent, respectively, of the total evaporative water losses, and skin losses 77.7 and 71.1 per cent. While these are only crude approximations, it is indicated that skin water loss is the major part of the total loss, and that extension of the wings to fully expose their surface area does not cause a proportionate increase in skin water loss.

The low rate of water loss from the flight membranes is not unexpected in view of the limited blood flow through the wings (Reeder and Cowles, 1951) which seems to be controlled at least partly by precapillary sphincters (Nicoll and Webb, 1946). In *Myotis yumanensis* there is no change in blood flow through the membranes when air temperature is increased or the bat is forced to be active, until the rectal temperature reaches 40–41°C., when there is a sudden engorgement of all blood vessels (Reeder and Cowles, 1951).

This leaves unclear the possible function of the wing fanning that occurs in overheated bats, even when air temperature exceeds body temperature. As proposed by Robinson and Morrison (1957), fanning may be correlated

with increased respiratory ventilation. Increased ventilation could cause some evaporative cooling, even if rectal temperature were less than air temperature, if the inspired air were not too humid.

Metabolism.—The resting bats quickly adjusted to the experimental chamber environment. Their metabolic rates reached a nearly stable minimum by the second or third hour of the experiments (Fig. 2). Body temperatures were not measured, but it is probable, judging from previous work such as that of Hock (1951), that the resting bats' body temperatures approximated air temperature in the chamber, i.e., 25–27°C. The estimated oxygen consumption of the resting bats during the third through seventh hours averaged 0.47 ml. O_2/gm. body wt./hr. ($s = 0.059$). This is about half the value found by Hock (1951) for resting *Myotis lucifugus,* 1.0 ml./gm./hr. at 26°C. as interpolated from his Fig. 2.

The bats with wings extended reached a minimum metabolic rate by the fifth or sixth hour of the experiments. Their metabolic rates declined from an average of 5.0 ml. O_2/gm./hr. (range 3.9–7.1 ml.) in the first hour to an

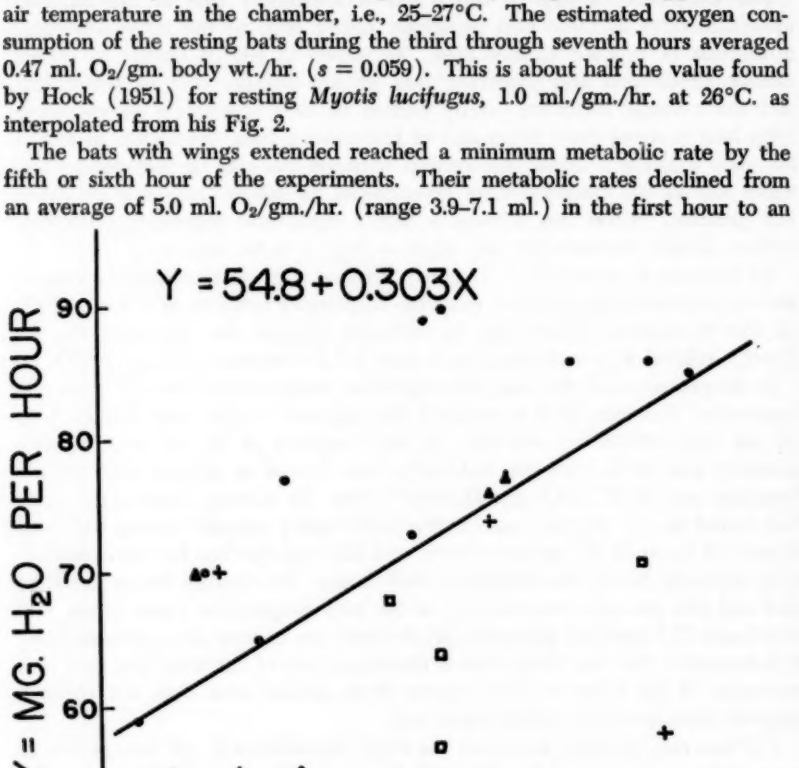

FIG. 3.—Relationship of evaporative water loss to carbon dioxide production in pallid bats with wings extended at 25–27°C. and 9–27% r.h. The different symbols represent five individual bats.

average minimum of 0.78 ml./gm./hr. (0.47–1.0) in the fifth or sixth hour. The bats did not struggle very much against their restraining bonds and their body temperatures were probably not more than a few degrees above air temperature, a differential that could be maintained by the heat from increased muscle tonus and movement in the extended position.

Water loss relative to oxygen consumption.—If water loss is expressed relative to oxygen consumption, the resting bats had an average loss of 0.44 mg. H_2O/ml. O_2 consumed ($s = 0.09$). This is less than the rates given by the Schmidt-Nielsens (1952) for various small mammals, including highly adapted desert species, which ranged from 0.50 mg./ml. for the pocket mouse, *Perognathus baileyi*, to 0.94 mg./ml. for the white rat. The low value for the bats may be partly or wholly due to the fact that they were exothermic during most of the measurement period while the rodents were fully endothermic. The water losses of an exothermic mammal can be expected to be less since it usually would be expiring air at a lower temperature, when it would hold less water vapor at saturation, and would have a lower skin vapor pressure due to reduced skin temperature.

When their wings were extended, the bats had an even lower ratio of 0.18 mg. H_2O/ml. O_2 (0.13–0.22) over the entire 6-hour experimental period. However, during the hour of their minimum metabolic rate the extended-wing bats had an average loss of 0.40 mg./ml., or approximately that of the resting bats. The difference between the water/oxygen ratios for the folded-wing and extended-wing experiments may be due to the difference in depth of breathing in these two situations. A higher ratio is to be expected in the resting bats, in which breathing was often so shallow as to be undetectable. In such shallow breathing only a small fraction of each breath penetrates the alveoli; the remainder ventilates only the dead air space. Only the alveolar fraction can participate in the measured oxygen consumption while the entire respiratory volume is effective in taking up water vapor.

SUMMARY AND CONCLUSIONS

1. *Antrozous pallidus* at 25–27°C. and 9–27 per cent relative humidity lose about 30 mg. water per hour by evaporation when hung up with wings folded, and 63–80 mg. per hour when restrained with wings extended.

2. This difference in rate of water loss is apparently due to the lower metabolic rate in the resting bats and the higher rate in the bats restrained with their wings extended. Water loss is significantly correlated with carbon dioxide production. There is no evidence that exposure of the flight membrane surfaces, in itself, increases evaporation.

3. Resting *A. pallidus* at 25–27°C. and 9–27 per cent relative humidity consume 0.47 ml. O_2/gm. body weight/hr.

4. In terms of metabolism, resting pallid bats lose 0.44 mg. H_2O/ml. O_2 consumed. This value is lower than those reported for desert rodents; the lowness is possibly due to the exothermic condition of the resting bats.

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ADDITIONAL REMAINS OF FLORIDA'S PLEISTOCENE VAMPIRE

BY STANLEY J. OLSEN

The present range of the vampire bat, *Desmodus*, is transequatorial, extending from northeastern and central México south to Uruguay and northern Argentina, and including the coastal islands of the Caribbean. The most northern limit of its range is Tamaulipas, México, which is about 130 miles south of the United States border. *Desmodus* is known from Pleistocene cave deposits in Cuba (Koopman, 1958) and from the San Josecito Cave near Nuevo León, México (Jones, 1958). However, the Florida vampire, *Desmodus magnus*, is known only from a Pleistocene cave in Marion County near Reddick, Florida (Gut, 1959). Although well known Pleistocene deposits are present in Sabertooth Cave, a few miles to the south, and in Haile and Arredondo, a few miles to the north, none of these localities has yielded up a single bone of the vampire from among the numerous vertebrate remains which have been collected from these sites. The accumulated bones of this animal came from a comparatively small area of what was once a large cave having several outside openings. The cave itself has been mined away for the limestone by the present owners, Dixie Lime Products Corporation, so that the once dark interior floor of the grotto is now open to Florida's sunshine.

Although the bones of insectivorous bats are common in other parts of the cave, none of these has turned up in close association with those of the vampire.

It is impossible to determine from the skeletons alone how large a colony existed in Reddick Cave during the Pleistocene, but present-day representatives of the genus usually consist of colonies of less than a hundred individuals, of both sexes.

It is not surprising, in view of the vampire's diet, that the accumulated

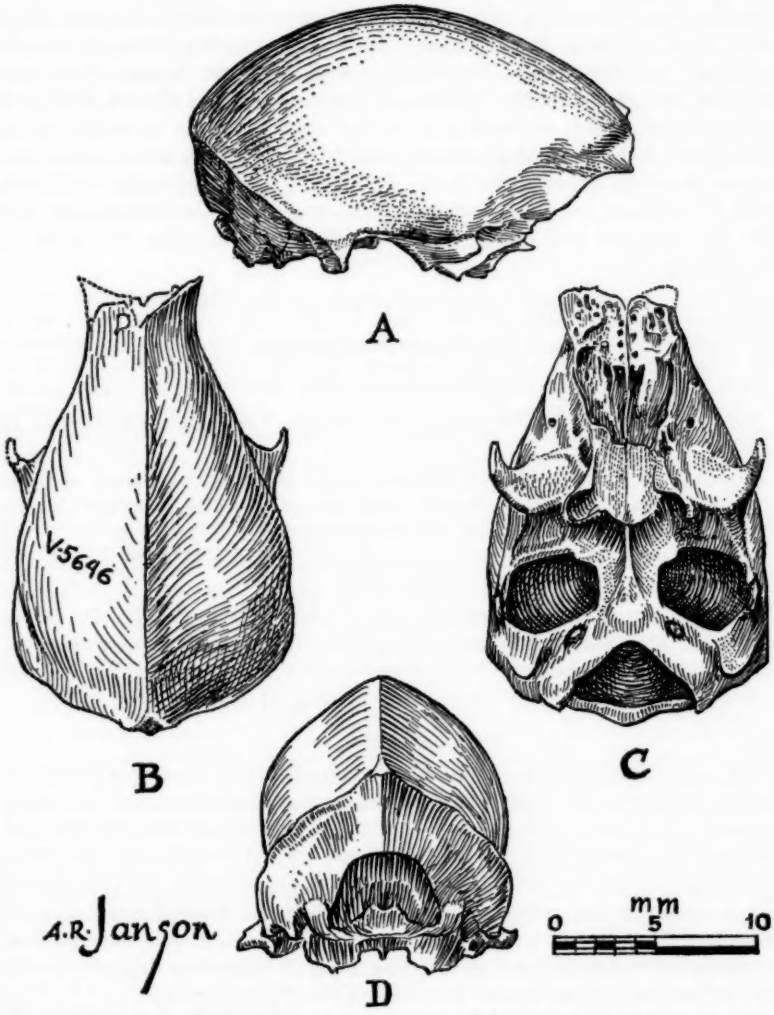

FIG. 1.—Cranium of *Desmodus magnus*; A, right lateral view; B, dorsal view; C, palatal view; D, occipital view.

excrement beneath their roosts is a characteristically blackened, tar-like, malodorous mass. The matrix in which the Reddick vampires were entombed was a dark snuff-colored materal, as compared with the light buff-colored sediment which is typical for the rest of the cave floor. The darkened matrix retained a pungent odor and was more "greasy" to the touch than was the matrix a few feet away.

In the type description of *Desmodus magnus* (Gut, 1959) the only difference given between this vampire and the present-day form, *Desmodus rotundus,* was one of size, the fossil animal being the larger. This same criterion was given for the Pleistocene species *D. stocki* (Jones, 1958). It would appear on this evidence that the two fossil forms are in reality synonymous and that the Florida animal should be termed *D. stocki.* However, a cranium (Fig. 1) collected by P. Brodkorb of the University of Florida exhibits sufficient morphological differences to support Gut's statements that this is a separate and distinct species, differing from either *D. stocki* or *D. rotundus.*

Family DESMODONTIDAE Gill 1884

Genus DESMODUS Maximilian 1824

Desmodus magnus Gut 1959

Type.—Florida Geological Survey, No. V-5935. Left lower jaw with C, P_3 and M_1.

Horizon and locality.—Bed 2, Illinoian stage of Pleistocene, mine of Dixie Lime Products Corporation, 1 mile southeast of Reddick, Marion County, Florida, in the southwest corner, NW¼ Sec. 14, T. 13 S, R. 21 E.

Referred material.—Florida Geological Survey, No. V-5646. Cranium (Fig. 1).

Material used for comparison.—Desmodus rotundus murinus ♀, A.M.N.H., No. 126456; *Desmodus rotundus murinus* ♂, A.M.N.H., No. 129754; *Desmodus* sp., M.C.Z. (Vertebrate Paleontology Collection), No. 4737; *Desmodus rotundus* ♂, M.C.Z. (Mammalogy Department Collection), No. 10445 (this specimen used by Koopman in establishing identity of Cuban fossil form).

DISCUSSION

The slight difference in size and the proportionately heavier structure of the bone that was observed in the type and referred specimens of *Desmodus magnus* is also quite apparent in the cranium of this animal. It is unfortunate that the rostral portions of the skull that were singled out as being diagnostic for establishing the species of *D. stocki* are not preserved in the Florida bat.

It is assumed that, since the area containing the critical morphological features of *D. magnus,* noted in the present discussion, is also preserved in *D. stocki* but not mentioned as differing from *D. rotundus,* this area is the same in both of the last named members of the Desmodontidae.

The paroccipital process of the exoccipital has a decided ventral deflection in *D. rotundus* as compared with the process which is flattened and directed

posteriorly in *D. magnus*. The glenoid fossae in both of the above species of *Desmodus* are shallow with the articular surface of *D. magnus* being relatively and actually the larger. The shape of this fossa indicates considerable freedom of movement between the upper and lower dentitions so that an effective shearing action can take place between the lancet-like teeth of this bat. The mastoid process of *D. magnus* is more pronounced than that seen in the compared specimens of *D. rotundus*. This process appears to lie in closer contact with the bulla in the latter form. There is a more noticeable step or swelling at the point of fusion between the basisphenoid and the basioccipital in *D. magnus* and the foramen hypoglossi is more pronounced in this animal.

In general, it was observed that the majority of the processes and foramina were more strongly developed and clearly visible in the Florida vampire than they were in the compared material.

SUMMARY

The fauna of the Reddick Cave is represented by typical Pleistocene cave dwellers and in the case of all other occurrences of Pleistocene vertebrates which coexisted with *Desmodus*, the one common large vertebrate that shared this cave with the vampire was the ground sloth. Since the Pleistocene vampire found ready prey in the form of this relatively easily obtainable food source, survival during the Pleistocene presented no problem for *Desmodus*. It is known that this bat attacks resting or sleeping animals, and that it can move about on the bodies of its victims, bite, and feed without arousing the hosts. This would make the sloth and larger cave dwellers, among the Pleistocene mammals, even more susceptible to the vampire. Two curious and unanswerable questions are: Did the vampire contribute to the death and eventual destruction of the sloth and other large warm-bodied animals of Pleistocene Florida? And, if so, did the vampire die out in this area when these hosts disappeared?

It is an accepted fact that the vampire is a vector of rabies and murrina. The latter disease is common to present-day horses and mules, and is caused by a trypanosome parasite after it enters the bloodstream of the animal. This parasite by itself cannot leave the bloodstream of the host, but has to be transferred and transmitted by another means. This transfer from one animal to another is easily effected by the biting and lapping action of a diseased vampire. A large-scale rabies epidemic occurred in southern Brazil and northern Argentina during the early part of this century and the vampire was shown to be the source of infection which killed thousands of horses and cattle. It is entirely possible that an epidemic of one of the above-mentioned diseases or one that is unknown today was a contributing factor toward the extinction of Florida's large Pleistocene mammal population. If this were true, it is not unlikely that the vampire had a share in spreading these infections among the larger animals that shared its cave.

Very little has been learned concerning the factors which limit the range of the common vampire, but it is known that this bat adapts itself to a rather widely diversified habitat. In México, for example, it is equally at home on the high central plateau or in the low-lying tropical coastal plain. Available evidence suggests that the environment of Florida today does not differ greatly from that of the Pleistocene. Since the vampire is more abundant in those areas within its range which contain limestone caves, Florida was well suited as a habitat for *Desmodus* during the Pleistocene and apparently this situation is little changed at the present time.

That this animal could pose a problem in relation to domesticated stock is apparent from observations which were made in areas where these bats now reside. The vampire seems

to be more abundant *nearer* to man's dwellings, than in neighboring wilderness areas. With the reintroduction into Florida of large herds of domesticated animals, it would appear that the niche for the vampire has been reopened, but so far as is known no vampire has been reported as occurring on the peninsula of Florida or, for that matter, in other parts of the United States in post-Columbian times.

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GEOGRAPHIC VARIATION IN THE YELLOW-NOSED COTTON RAT

By James S. Findley and Clyde J. Jones

The yellow-nosed cotton rat, *Sigmodon ochrognathus* Bailey, occupies foothill and mountain situations from southeastern Arizona (Hoffmeister and Goodpaster, 1954) east to the Big Bend of Texas (Borell and Bryant, 1942) and south to Parral, Chihuahua (Fig. 1). In the 60 years since the species was described from the Chisos Mountains (Bailey, 1902: 115) few specimens have been taken, and little has been learned about the natural history of the animal. The presence of the species in Arizona was revealed by Benson (1940: 157–158) who referred animals from the Huachuca Mountains and from San Luis Pass, Hidalgo Co., New Mexico, to a new subspecies, *Sigmodon ochrognathus montanus*, type locality, Peterson's Ranch (Sylvania), 6,100 ft., Huachuca Mountains, 2 mi. N Sunnyside, Cochise Co., Arizona. In 1947, Goldman and Gardner (1947: 57–59) commented on the species and described as new *S. o. madrensis* based on two specimens from the foothills of the Sierra Madre Occidental, about 30 miles northwest of Parral, 6,200 ft., Chihuahua. Subsequently, specimens have been recorded from the Davis Mountains, Jeff Davis Co., Texas (Blair, 1940: 32), from Sierra del Carmen and Sierra de la Madera, Coahuila (Baker, 1956: 278–279), from west-central and northwestern Chihuahua (specimens in University of Kansas Museum of Natural History), from the Animas and Peloncillo Mountains, New Mexico (University of New Mexico Collection of Vertebrates), and from the Pajarito and Baboquivari Mountains, Arizona (Hoffmeister, 1959: 17–19).

Our aim has been to evaluate the geographic variation shown by this species. In this we have been aided by the courtesy of Stanley P. Young, U.S. Fish and Wildlife Service, E. R. Hall, University of Kansas Museum of

Natural History, Emmet T. Hooper, University of Michigan Museum of Zoology, Frederic W. Miller, Dallas Museum of Natural History, and William Z. Lidicker, Jr., Museum of Vertebrate Zoology at the University of California, Berkeley, to whom we are grateful for allowing us to examine specimens under their care. Field work in New Mexico was made possible by grants from the University of New Mexico Research Committee and from the National Science Foundation.

Within its geographic range *Sigmodon ochrognathus* is known to occur in the altitude range from 3,800 to 8,400 feet. The average altitude of 14 stations of capture is 6,300 feet, and half of the stations are between 5,000 and 7,000 feet. In a general way the species occurs from the upper limits of the grassland into the pine-oak forests. At its higher stations of occurrence the species is associated with various conifers and oaks. For example, at 8,000 feet near the top of the Animas Mountains, New Mexico, the animals were taken in runways in the grass near *Pinus reflexa, Pseudotsuga taxifolia, Pinus cembroides, Juniperus deppeana, Quercus hypoleucoides* and *Q. reticulata.* At the mouth of Indian Creek Canyon, at the base of the Animas Range, approximately 6,000 feet, the animals were found among bunch grass, *Yucca, Agave* and prickly pear. Several authors have noted the runways of the animals leading through grass from one yucca or clump of beargrass (*Nolina*) to another. Other plants with which the animals are

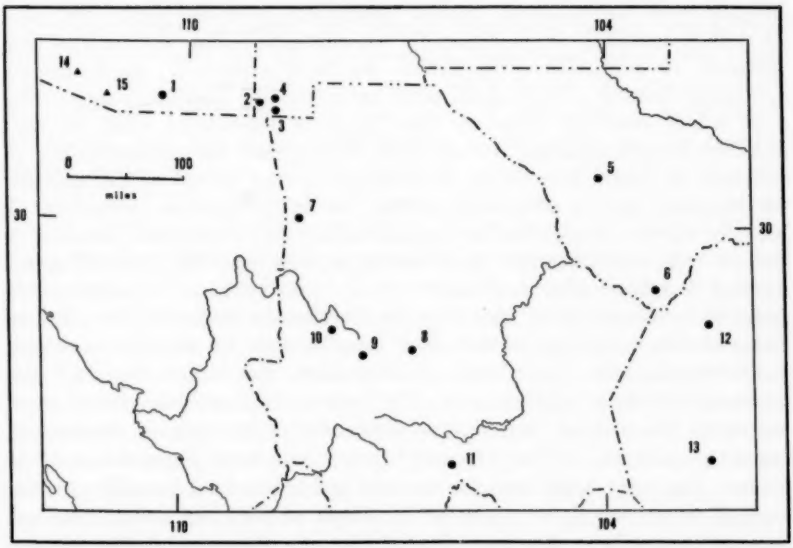

FIG. 1.—Distribution of *Sigmodon ochrognathus.* Dots indicate specimens examined; triangles represent literature records. Numbers refer to localities in list of specimens examined in text.

frequently associated are *Dasylirion*, evergreen oaks, *Fouquieria, Prosopis, Mimosa, Acacia, Arctostaphylos* and *Cercocarpus*. Usually the cotton rats occur on slopes in rocky areas. The habitat described has a disjunct distribution in the southwest, as do yellow-nosed cotton rats.

Cranial morphology.—Distinctive cranial features mentioned in the original descriptions of *S. o. montanus* and *S. o. madrensis* involve size of the audital bullae, relative width of skull, configuration of zygomata, relative length of rostrum, and arching of braincase. We have checked these features as well as others on the material available to us.

Sigmodon ochrognathus montanus is said to differ from *S. o. ochrognathus* in having smaller audital bullae, (Benson, 1940: 157–158). In comparing 19 specimens of *montanus* (five topotypes and 14 specimens from Animas and Peloncillo Mountains, New Mexico) with 20 specimens of *S. o. ochrognathus* (five topotypes and 15 specimens from Davis Mountains, Texas) we cannot see a constant difference in bullar size.

Sigmodon o. madrensis is said to differ cranially from both *S. o. ochrognathus* and *S. o. montanus* in: skull "more elongated and relatively narrower than either; zygomata narrower posteriorly, less converging anteriorly, the sides more nearly parallel; rostrum more elongated, less depressed anteriorly; braincase more highly arched" (Goldman and Gardner, 1947: 58). We have not been able to examine the type of *S. o. madrensis*, but have examined the one other known specimen of the race, a juvenile with unerupted M^3. Judging from the published cranial measurements of the type (*loc. cit.*) its skull is extremely large, larger by 3.6 millimeters than the skull of any specimen of *Sigmodon ochrognathus* we have examined. Measurements indicating breadth of the skull, such as zygomatic breadth, suggest that it is indeed relatively narrower than skulls of animals of other nominal races of *S. ochrognathus*. In an effort to increase our understanding of variation of cranial proportions of *Sigmodon* owing to age of the animals, we prepared scatter diagrams, plotting various dimensions indicative of breadth against condylobasilar length, under the assumption that, in a general way, condylobasilar length increases with age. We used all specimens of *S. ochrognathus* available to us, and also made use of an extensive series of *S. hispidus* of all ages from the Rio Grande Valley in New Mexico. These studies convinced us that skull breadth does not increase at a rate commensurate with skull length in *Sigmodon*; the larger the skull the narrower it is in a relative sense. The outsize skull of the type of *S. o. madrensis* fits perfectly on a curve expressive of the rate of increase of zygomatic breadth relative to condylobasilar length in *Sigmodon ochrognathus*. The same holds true for mastoid and interorbital breadth. In like manner, rostral length, as expressed by length of the nasal bones, does not increase as rapidly as does condylobasilar length. Hence, while the rostrum of *S. o. madrensis* is actually quite long, it is relatively shorter, not longer, than the rostra of skulls of *S. o. ochrognathus* and *S. o. montanus*. It is

about the relative length one would expect from the projection of a curve expressive of rate of rostral increase in *S. ochrognathus*. Examination of skulls of both *S. ochrognathus* and *S. hispidus* shows that the rostrum becomes less depressed anteriorly with increasing size of the skull. Again, the large size of the type of *S. o. madrensis* would seem to account for its supposed diagnostic features. Zygomatic configuration varies with age and individually in samples of *Sigmodon* we have studied; we are not inclined to place much weight in this feature as an indicator of regional genetic differentiation. The statement regarding the arching of the braincase is not entirely clear to us. The braincase may be arched in lateral profile or in cross section. With increasing age, braincases of *Sigmodon* become deeper, but no wider, giving the appearance of increasing arching in cross section. It may be that this is what is referred to in Goldman and Gardner's statement. We see little geographically significant difference in the arching in lateral profile of any of the skulls we have examined.

The large size of the type and one known adult specimen of *S. o. madrensis* may seem to indicate that the population of which it is a representative is composed of animals which are larger, on the average, than animals from other populations of the yellow-nosed cotton rat. For reasons cited below we think that this may be true not only of "*madrensis*" but also of all populations of *Sigmodon ochrognathus* from the western side of the Mexican Plateau. In comparing samples of skulls of *S. ochrognathus* from the Chisos and Davis Mountains with samples from New Mexico, Arizona and Chihuahua, we note that the largest skulls from Texas are slightly larger than the largest western skulls but, when skulls of like size are compared, the skulls from Texas show more tooth wear. If tooth wear is indicative of age in this case, one might conclude that at any given age the western animals would be larger. We do not have western specimens which show as much tooth wear as the larger Texan specimens. We feel that in our sample of western material we simply do not have any old adults and that, if we did, their skulls would be comparable in size and proportions to that of the type of *S. o. madrensis*. It may thus be that west-Plateau animals of *Sigmodon ochrognathus* attain a larger adult size than do east-Plateau animals. Such size differences may be a result of genetic difference, but are equally likely to result from nutritional or other environmental differences. Work which we have currently in progress on New Mexican microtine rodents suggests to us that seasonal climatic differences may affect the adult size of young born at different times of year, so that samples of the same age from the same locality taken at different times of year, or from the same season of different years, may differ in average size or in proportions. This phenomenon was noted in arctic microtines by Bee and Hall (1956: 146–147).

In summary, none of the cranial features mentioned by previous students

of S. *ochrognathus* as being diagnostic of the several races seems to us to be indicative of geographic genetic differentiation.

This is not to say that there are no geographic trends in cranial morphology of these animals. Our studies reveal slight, average geographic differences as follows:

In specimens from the Chisos and Davis Mountains the maxillary toothrows are rather markedly convergent anteriorly (noticeable in 86 per cent). This tendency diminishes markedly in samples from west of the Rio Grande. Convergence is seen in only 38 per cent of specimens from Sierra del Carmen, in 20 per cent of New Mexican specimens, in 40 per cent of Arizonan examples, and in none of the specimens from Ocampo and Pacheco. Also, specimens from Texas show a strong tendency to possess maxillary toothrows which are bowed laterally. This is noticeable in the following percentages of specimens from the localities represented: Chisos Mts., 57; Davis Mts., 79; Sierra del Carmen, 13; near Ocampo, Coahuila, 0; New Mexico, 14; Pacheco, Chihuahua, 0; and Arizona, 0. The presence or absence of these features was determined by us in a subjective way, and the percentages are, therefore, approximate. Nonetheless, a definite tendency for Texan populations to display bowed, anteriorly convergent toothrows is demonstrated.

Comparing populations from east of the Mexican Plateau (Texas, Coahuila) with those from west of the Plateau (Chihuahua, New Mexico, Arizona), skulls of eastern specimens are seen to have, on the average, relatively broader rostra. However, there is a slight indication from the data available that the rate of increase of rostral breadth increases in older animals, so that the eastern specimens which, as indicated above, seem to be older than western animals of like size, would be expected to have relatively wider rostra.

Color variation.—Most of the color variation we observe between our samples of skins seems to us to be owing to differences in age and season. While our material is not adequate to give us a complete picture of pelage sequence in these animals, we are able to detect some general trends. Animals in fresh juvenile pelage may be exceedingly buffy in appearance. Goldman and Gardner (1947: 58) comment upon the ochraceous-tawny appearance of the juvenile topotype of S. *o. madrensis* compared with specimens of S. *o. ochrognathus* of corresponding age. We note this ochraceous-tawny suffusion but find it even more pronounced in a juvenile topotype of S. *o. ochrognathus* (UMMZ 95894). Five specimens in comparable pelage from Sierra del Carmen are not so buffy, but are darker, as is a specimen from the Animas Mountains. The hairs on the inside of the ear pinnae are frequently buffy, whereas in adults these hairs may be gray or buffy. Adult winter pelage is darker than adult summer pelage; also fresh adult pelages seem darker and less buffy than worn ones.

Of six topotypes of S. *o. montanus* which we have examined, five were taken from 29 July through 6 August 1931. These five seem to be in summer

pelage and are markedly paler than specimens from elsewhere in the range of the species except for some individuals in worn pelage from the Chisos Mountains. A specimen referred to as *S. o. montanus* by Benson, from 4 mi. NW San Luis Pass, Hidalgo Co., New Mexico, taken 1 September 1931, is likewise pale. We are tempted to conclude that *S. o. montanus* is a pale race except for the following facts: (1) virtually all other specimens of *Sigmodon ochrognathus* before us are in winter pelage and hence would be expected to be darker than the specimens of *S. o. montanus*; (2) one topotype of *S. o. montanus*, taken 15 March 1940, is in winter pelage and is much darker than the summer-taken topotypes, but closely matches topotypes of *S. o. ochrognathus* in similar pelage as it does specimens of *S. ochrognathus* from west-central Chihuahua and other places; (3) the specimen referred to from San Luis Pass, while pale and matching the summer-taken topotypes, is much paler than the 12 winter-taken specimens of *S. ochrognathus* from the Animas Mountains just a few miles north of San Luis Pass, and also than three specimens in fresh winter pelage (3 Nov. 1954) from Pacheco, Chihuahua, a few miles to the south.

Comparisons of the samples from other parts of the range of the species, most of which, as noted, are in winter pelage, reveals little in the way of constant geographic color differences. Such features as color of hairs on the inside of the ears, color of dorsal surfaces of feet, and sharpness of tail bicoloration vary in a random fashion among adults. Specimens from some stations, such as from 20 mi. S and 4 mi. W Ocampo, Coahuila, have less rich ochraceous coloration about the nose than do those from other places. Many of the specimens from the Sierra del Carmen seem to have pelages more richly suffused with buff, but we feel that this is partly owing to foxing and greaseburning in these animals.

In short, we are able to detect no features of coloration which definitely characterize any one population of *S. ochrognathus* as opposed to any other.

Body proportions.—To study size of ear pinna, used as a feature to distinguish *S. o. montanus* from *S. o. ochrognathus*, we measured the dried ears of all our specimens with a dial caliper and expressed ear length as a percentage of condylobasilar length. We found no significant geographic variation in ear size. We studied tail length expressed as a percentage of total length, and found no significant geographic variation in this proportion.

Specimens examined, 71. Number in parentheses preceding locality refers to Fig. 1. Arizona: *Cochise County:* (1) Peterson's Ranch, 6,100 feet, 2 mi. N Sunnyside, Huachuca Mts., 4 (MVZ); (1) mouth of Miller Canyon, Huachuca Mts., 1 (UMMZ); (1) head of Miller Canyon, 8,400 ft., Huachuca Mts., 1 (MVZ). New Mexico: *Hidalgo County:* (2) pass on Geronimo Trail at top of Peloncillo Mts., 22 mi. S and 2 mi. E Rodeo, 1 (UNMCV); (3) 4 mi. NW San Luis Pass, 5,200 ft., Animas Valley, 1 (MVZ); (4) Indian Creek Canyon, 6,000 ft., 22 mi. S Animas, Animas Mts., 3 (UNMCV); (4) Aspen Spring, 7,300 ft., Indian Canyon, Animas Mts., 5 (UNMCV). Texas:

Jeff Davis County: (5) south slope of Mt. Locke, 6,000 ft., Davis Mts., 7 (UMMZ); (5) upper Limpia Canyon, 5 mi. E Mt. Livermore, Davis Mts., 7 (UMMZ). *Brewster County:* (6) Chisos Mts., 9 (7 UMMZ, 2 USBS). Chihuahua: (7) 3 mi. SW Pacheco, 3 (KU); (8) 8 mi. NE Laguna, 7,250 ft., 3 (KU); (9) 2 mi. W Minaca, 6,900 ft., 2 (KU); (10) Cherry Ranch, 11 mi. NW Cocomorachic, 1 (KU); (11) foothills of Sierra Madre, about 30 mi. NW Parral, 1 (USBS). Coahuila: (12) Juarez Canyon, 4,800 ft., Sierra del Carmen, 16 (DMNH); (13) 20 mi. S and 4 mi. W Ocampo, 5,300 ft., Sierra de la Madera, 3 (KU).

Other records of occurrence (Hoffmeister, 1959: 17–19). Arizona: *Pima County:* (14) Allison Mine, 11 mi. E Topawa, Baboquivari Mts. *Santa Cruz County:* (15) 2½ mi. NE Pajarito Peak, 4,000 ft., Pajarito (Tumacacori) Mts.

Abbreviations following numbers of specimens examined refer to collections as follows: MVZ, Museum of Vertebrate Zoology; UMMZ, University of Michigan Museum of Zoology; UNMCV, University of New Mexico Collection of Vertebrates; USBS, Biological Survey Collection; KU, University of Kansas Museum of Natural History; DMNH, Dallas Museum of Natural History.

Discussion.—While we observed some rather vague geographic trends in morphology and color of the yellow-nosed cotton rats, we detected no strong regional differentiation such as one might expect of populations of mammals which have long been isolated from one another, or which have been under the influence of differing selective pressures. To the extent that time may be a factor in local differentiation of mammals we have the impression that the presently disjunct range of *Sigmodon ochrognathus* has not long been established. It would follow that the presently disjunct habitat of *S. ochrognathus,* centered about live oak encinal, has not long been disjunct. Martin (1957: 240–242) postulated that the Mexican montane biota of the Chiricahua Mountains, including *Sceloporus jarrovi, S. scalaris, Crotalus pricei,* various oaks and Mexican pines, reached that station during a postglacial period of heavy summer rains, perhaps as early as the Sulfur Spring stage of Sayles and Antevs (1941) dated by Libby (1955) as between 6210 and 7756 B.P. Martin thinks that the present disjunct montane distribution pattern of the Madrean biota resulted from ensuing desiccation. We incline toward acceptance of this sequence of events and think that the range of *S. ochrognathus* probably became disjunct contemporaneously with that of the Madrean biota, or possibly a bit later, since the habitat of the animal seems to center in encinal rather than in pine-oak woodland. The habitat of the yellow-nosed cotton rat may be almost the most recently fragmented biotic zone in the southwest. Possibly the grassland, which forms a skirt about some desert mountain ranges in Arizona and New Mexico, with encinal above and creosote bush desert below, was continuous more recently. At any rate, the slight degree of geographic variation seen in the yellow-nosed cotton rat is consistent with the postulated history of its habitat.

We are not especially concerned with nomenclatorial questions related to these cotton rats. We do feel that the trinomial has a definite place and use in biogeographic studies. The application of a trinomial to a population of animals, we think, should connote definite recognizable genetic differentiation in that population. The fact of this differentiation, made public by the use of the trinomial, is a useful datum for the biogeographer, ecologist and evolutionist.

Our impression is that the differentiation seen in *Sigmodon ochrognathus* does not warrant the use of the trinomial.

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THE SUMMER BURROWING ACTIVITY OF POCKET GOPHERS

By RICHARD S. MILLER AND HENRY E. BOND

The burrow system of a pocket gopher consists of a network of feeding tunnels joined to a less extensive system of connecting tunnels, food caches and nests. The horizontal feeding tunnels usually lie within a few inches of the ground and lead to lateral tunnels which terminate at the surface in typical excavation mounds (cf. M. A. Miller, 1957). Numerous authors have used the number of excavation mounds produced as a measure of burrowing activity, and have generally concluded that pocket gophers are most active

in spring and fall in temperate regions and during the rainy season in warm, dry areas. M. A. Miller (1946, 1957), for example, has shown that the burrowing activity of *Thomomys bottae* populations in irrigated alfalfa fields in California varies with changes in soil moisture. Increased soil moisture, either through precipitation or irrigation, produces a corresponding increase in the number of excavation mounds produced. Crouch (1933), on the other hand, offers an alternative suggestion which implies that excavation mounds are not a reliable index of burrowing activity. Crouch found that pocket gophers burrow deeper when the soil near the surface is dry, and suggests that they may at the same time deposit excavated soil in unused tunnels, instead of bringing it to the surface to form excavation mounds. Thus, reduced surface activity may not indicate a total reduction in burrowing activity. However, neither of the above hypotheses (Crouch, 1933; Miller, 1957) explains the apparent lack of activity in mountain populations of *T. talpoides* during late spring and early summer, when soil moisture is high and, presumably, ideal for burrowing (cf. Laycock, 1957). The purpose of this study was to measure the burrowing activity of *T. talpoides* populations throughout the summer, and to determine the effects of soil moisture on the observed trends.

METHODS

The study was conducted during the summers of 1957 and 1958 on Black Mesa, Gunnison County, Colorado. Black Mesa is a plateau at an elevation of 9,800 to 10,500 feet. The vegetation is primarily spruce-fir and aspen forest with large grassland parks. All of the plots were situated in grassland parks with an east-southeast exposure, but the vegetation, soil depth and slope of the plots varied as shown in Table 1.

Burrowing activity.—All of the existing excavation mounds were obliterated at the beginning of observations on each plot. After an appropriate interval, the new mounds that had been produced were counted and, in turn, obliterated. In 1957 the mounds were counted every seven or eight days, but as many as 480 mounds were produced on the one-acre plot and it was felt that this many mounds on such a large area was liable to introduce an error in counting. The plot size was reduced to ¼ acre and the census interval to three days in 1958.

In order to reduce the mound counts on each plot to comparable values, burrowing activity was calculated as follows:

$$\frac{\text{number of mounds produced/days}}{\text{number of gophers on plot}} = \text{mounds/gopher/day.}$$

The number of gophers on each plot (Table 1) was determined by a trap-out with standard Macabee traps immediately after the last mound census on each plot. Pocket gophers are rather sedentary and there was little danger of the trap-out being affected by immigration or emigration during the trap-

TABLE 1.—*Characteristics of study plots*

Plot:	A	B	C	D	E
Period of observation	1 Jul to Sep 18 1957	17 Jun to Sep 3 1958	17 Jun to Sep 3 1958	17 Jun to Aug 4 1958	17 Jun to Aug 4 1958
Area (acres)	1	¼	¼	¼	¼
Slope (per cent)	0–3	0–3	15+	0–7	0–7
Soil depth (inches)	—	3–18	10–14	3–9	3–9
Dominant vegetation	Grass	Grass	Grass	Forbs	Forbs
Gophers per acre	20	28	24	20	28

ping; but the mound counts were made during and after the breeding season and the population densities undoubtedly varied during the study.

Soil moisture.—Soil samples were taken with a standard, ¾ inch diameter sampling tube. On each sampling date (Table 2) three cores were taken on each plot at a depth of 0 to 12 inches. The cores were weighed, oven-dried, and weighed again. The results from the three cores were combined and the average soil moisture on each plot determined. A preliminary analysis of variability showed that this number of cores provided an adequate sample.

In his study of the burrowing activity of *T. bottae* populations, M. A. Miller (1948, 1957) found that about 80 per cent of the total footage of

TABLE 2.—*Average soil moisture (0 to 12 inches) on plots A–E during the summers of 1957 and 1958*

Date	1957	1958				
	Plot A	Plot B	Plot C	Plot D	Plot E	Average B–E
17 June	—	19.8	19.1	15.8	22.8	19.4
26	—	16.2	12.0	12.2	16.8	14.3
3 July	—	14.4	13.6	9.2	14.6	13.0
7	26.8	—	—	—	—	—
11	19.8	—	—	—	—	—
17	—	12.0	10.0	7.0	7.2	9.0
18	17.8	—	—	—	—	—
25	26.0	—	—	—	—	—
31	—	11.4	9.4	5.4	7.6	8.5
1 Aug.	35.8	—	—	—	—	—
7	—	10.7	10.2	—	—	10.4
8	29.0	—	—	—	—	—
15	25.1	9.6	8.2	—	—	8.9
20	—	11.8	8.0	—	—	9.9
22	29.0	—	—	—	—	—
28	—	10.5	16.5	—	—	13.5
29	24.2	—	—	—	—	—
5 Sept.	33.0	—	—	—	—	—
12	24.3	—	—	—	—	—
19	21.6	—	—	—	—	—
Mean	26.0					11.9

tunnels lay within 12 inches of the ground surface. Nearly 40 per cent were at a modal depth of 6 to 8 inches. Since the gophers on Black Mesa live in coarser and shallower soils, they presumably construct their tunnels at even shallower depths (M. A. Miller, 1957) and core samples to a depth of 12 inches should give an adequate sample of the effective soil moisture.

RESULTS

The total annual precipitation on Black Mesa is about 30 inches and occurs mostly as winter snow. A total of 7.63 inches of precipitation was recorded during July, August and September 1957 at a U.S. Forest Service rain gauge near the plots. Precipitation in 1958 was more normal, when 2.15 inches were recorded during the months of June, July and August. This difference in precipitation between the two summers is reflected in the soil moisture values shown in Table 2. The average soil moisture from 7 July to 19 September was 26.0 per cent. During July the average was 22.6 per cent and subsequent precipitation increased soil moisture to 28.6 per cent during August and 26.3 per cent during September. From 17 June to 28 August 1958 the average was only 11.9 per cent. The average for the latter part of June was 16.9 per cent, and there was then a decrease to 10.1 per cent in July and 10.7 per cent in August 1958. Thus the over-all trends in soil moisture, as well as the average amounts, were markedly different.

The burrowing activity recorded during the two summers is shown in Table 3. The mounds were obliterated on 1 July on plot A in 1957, and the first observation was made on 9 July. Little surface activity was recorded before the end of July, but there was a consistent increase during August to a peak of 3.4 mounds per gopher per day on 26 August. This peak was followed by a slight decline to an average of approximately 2.4 mounds per gopher per day until the last observation on 18 September.

A similar trend occurred on plots B-E during 1958. Little surface activity was recorded before late July, after which there was a more erratic, but relatively steady, increase in activity to a peak of 2.9 mounds per gopher per day on 30 August 1958. Figure 1 shows a comparison between soil moisture and burrowing activity for the two years. In spite of the differences in soil moisture, the activity trends are similar and it seems obvious that soil moisture conditions had little effect, if any, on the patterns of activity that were expressed.

DISCUSSION

An understanding of population dynamics, whether for purposes of artificial control or to determine the factors involved in natural control, requires a thorough knowledge of activity patterns (R. S. Miller, 1955); but, because of their solitary, subterranean existence, the behavior of pocket gophers is difficult to study and very little is known of their intraspecific relations. The results of this study show no clear correlation between the period of reduced

TABLE 3.—*Burrowing activity of pocket gophers*

Date	MOUNDS/GOPHER/DAY					
	1957	1958				
	Plot A	Plot B	Plot C	Plot D	Plot E	Average B–E
17 June	—	—	—	—	—	—
20	—	.2	.3	.1	.0	.1
23	—	.4	.3	.3	.1	.3
26	—	.2	.6	.4	.3	.4
29	—	.3	1.0	.3	.1	.4
1 July	—	—	—	—	—	—
9	.1	—	—	—	—	—
14	—	.2	.6	.2	.2	.3
15	.2	—	—	—	—	—
17	—	.4	.8	.4	.3	.5
20	—	.5	1.2	.6	1.5	1.0
22	.3	—	—	—	—	—
23	—	.3	.8	1.0	1.3	.8
30	.7	—	—	—	—	—
1 Aug.	—	.6	1.3	.6	.7	.8
4	—	.8	1.6	.7	.9	1.0
5	1.8	—	—	—	—	—
7	—	.8	1.7	—	—	1.2
10	—	.7	.9	—	—	.8
12	2.4	—	—	—	—	—
13	—	1.0	1.3	—	—	1.2
16	—	1.6	1.9	—	—	1.7
19	2.7	1.4	1.4	—	—	1.4
26	3.4	—	—	—	—	—
27	—	2.0	2.7	—	—	2.3
30	—	2.3	3.7	—	—	2.9
3 Sept.	2.3	1.8	2.5	—	—	2.1
9	2.7	—	—	—	—	—
18	2.3	—	—	—	—	—

activity during early summer and observed external factors. Moreover, the data suggest that the inactive period is a general population phenomenon, since it occurs regardless of annual differences in soil moisture and local site differences in habitat. It does, however, coincide with the breeding season, and it is suggested that the activity trends noted in this study are a product of behavioral changes induced by the breeding cycle.

The burrow system of a pocket gopher constitutes both its home range and territory, and is vigorously defended against intruders throughout most of the year. Until recently, it has been assumed that this system of individual territories was virtually inviolate, and that plural occupancy of burrows was a comparatively rare phenomenon associated only with a brief mating period. Unfortunately, however, few studies of pocket gopher populations have been designed in such a way that intraspecific associations could be evaluated, and the few accounts of plural captures have been given undue emphasis.

Wight (1930), in a study of the breeding habits of *T. talpoides* in eastern Oregon, found that about 50 per cent of the burrows were occupied by more than one gopher during a 34-day period in March and April. Of the 462 gophers trapped by Wight, 68.8 per cent were taken from burrows occupied by one or more additional gophers. More recently, Hansen and Miller (1959) have shown that mountain populations of *T. talpoides* in Colorado behave in a similar fashion and territorial defense is considerably relaxed during the breeding season. Various combinations of juveniles and adult males and females occur together during June and most of July, but during August, as the juveniles mature and disperse from the parent burrows, there is a gradual return to a system of individual territories. The areas studied by Hansen and Miller (1959) are inaccessible before June and data for the complete breeding season are not available, but adult males and females presumably occur together during the early part of the breeding season also, as reported by Wight (1930) for populations in Oregon.

Since the breeding season and the intraspecific associations mentioned above coincide with the period of reduced activity recorded in this study, the lack of burrowing activity during June and July may be explained by

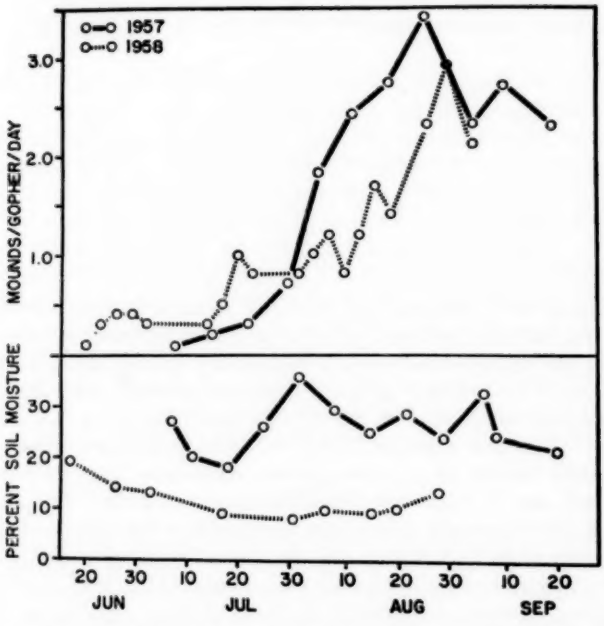

FIG. 1.—A comparison between burrowing activity and soil moisture during the summers of 1957 and 1958.

the fact that the adults are involved in caring for the young and, therefore, spend less time burrowing. Moreover, A. L. Ward (unpublished MS) has shown that this period is also characterized by above-ground feeding, so that surface foraging may also replace burrowing and construction of feeding tunnels. The increase in activity during August probably represents a sequence of behavioral changes associated with dispersal of the young from the parent burrows, a return to a system of individual territories, and a gradual change in behavior from surface feeding to subterranean feeding as the vegetation matures and the leaves and stems become less palatable.

Thomomys bottae populations in California breed throughout the year (M. A. Miller, 1946; Gunther, 1956), so that the lack of burrowing which may be associated with breeding is not expressed as a seasonal phenomenon. The lack of a pronounced breeding cycle also explains the fact that M. A. Miller (1946) recorded captures of more than one gopher in a burrow system during all seasons.

SUMMARY

The burrowing activity of the mountain pocket gopher, *Thomomys talpoides*, was studied during the summers of 1957 and 1958 on Black Mesa, Colorado. Relatively little activity was recorded during June and July, but burrowing increased during August to a peak in late August. The seasonal trend in activity was not correlated with precipitation and soil moisture but seemed, instead, to represent seasonal changes in breeding behavior and feeding habits.

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A REVISION OF THE WOOD RAT *NEOTOMA STEPHENSI*

By Donald F. Hoffmeister and Luis de la Torre

Within the last few years, some field guides to mammals of the United States have appeared which do not include the wood rat *Neotoma stephensi*. The implication is that *Neotoma stephensi* is not a valid species. Some specific characters of *Neotoma stephensi* were enumerated in the original description by Goldman in 1905, and its specific distinctness (from *Neotoma lepida*) was reaffirmed by Goldman in 1932. Because of the previous confusion of *Neotoma stephensi* with *Neotoma lepida*, and even the subsequent confusion of the two species following Goldman's review (Jour. Mamm., 13: 59–67, 1932), it is somewhat understandable that some authors might question the validity of *stephensi*. Even the recently published work by Hall and Kelson (The Mammals of North America, 2: 690, 1959) fails to show the coexistence of *N. lepida* and *N. stephensi* in parts of their range, a fact which lends additional evidence for the distinctness of the two species. With more adequate material, and using Goldman's work as a starting point, we have attempted to define more clearly the species *N. stephensi*.

Many persons have made available, for study, specimens of *Neotoma stephensi* in their collections. We should especially like to thank Richard G. Van Gelder, Stanley P. Young, Viola Schantz, Laurence Huey, Seth B. Benson, William Z. Lidicker, and William H. Burt. Specimens from the following collections have been examined (the abbreviations in parentheses are used under *Specimens examined*): American Museum of Natural History (AM); United States Biological Survey (BS); Grand Canyon National Park Museum (GC); San Diego Society of Natural History (SD); University of California, Museum of Vertebrate Zoology (UC); University of Illinois, Museum of Natural History (UI); University of Michigan, Museum of Zoology (UM). Capitalized color terms are from Ridgway (Color Standards and Color Nomenclature, 1912). All measurements are in millimeters. Under *Additional records* we have included localities from which the species is known but from which we have not examined specimens. The Graduate College of the University of Illinois has financially aided us in this study. Illustrations were prepared by Alice A. Boatright and Harry C. Henriksen of the University of Illinois.

GENERAL CHARACTERS OF THE SPECIES

Obvious characters of *Neotoma stephensi*, which in part are diagnostic, are the presence of a semi-bushy tail (bushier than in all species except *N. cinerea*) in a medium- to small-sized *Neotoma*; dusky coloration extending down the top of the foot one-fourth to one-third the distance below the ankle; skull resembling *N. lepida*. A closer study indicates the following characters are diagnostic:

Baculum.—Exclamation-mark-shaped or wedge-shaped (Fig. 1); small, being one-fifth or less than the length of the baculum in *N. lepida*; smaller than in

any species of *Neotoma* found in the United States; similar in size and shape to that of *Neotoma phenax*, except not indented along sides and thus not "violin-shaped." When everted from the prepuce, the distinctively small size of the baculum in *N. stephensi* is clearly noticeable, and in contrast to the condition in *Neotoma lepida*, *N. albigula*, and *N. mexicana*. In one specimen of *N. s. relicta*, the baculum is identical to that in *N. s. stephensi*.

Skull.—TEETH: The pattern of M^3 together with features of M^1 serves to distinguish *N. stephensi* in most cases. In M^1, the antero-medial fold is usually absent or, if present, is shallow, approaching *albigula*, never deeply re-entrant as in *mexicana*. In M^3, the postero-labial fold (Fig. 1) is directed postero-medially and "terminates" posterior to the lingual fold. In *N. lepida*, the postero-labial fold (Fig. 1) is directed medially and less posteriorly, nearly meeting the lingual fold. In M^3 of *stephensi*, the second loph is usually long and narrow, extending diagonally across the tooth (Fig. 1). In this regard, it is similar to *N. mexicana* and *N. albigula*, but differs from *N. lepida* in which the second loph is usually broad labially and nearly at right angles to the long axis of the toothrow (Fig. 2).

In *N. stephensi*, the lingual fold of M_3 is as deep as or deeper than the labial fold (Fig. 2), whereas in *N. lepida* and *N. albigula*, the lingual fold is shorter than the labial fold. In *N. mexicana*, both conditions seem to occur.

ROSTRUM: The rostrum is narrower than in any other species within the range of *N. stephensi* (Fig. 3). Generally, the nasals in *stephensi* are truncate posteriorly, rarely sharply pointed as is common in *lepida* and *albigula* (Fig. 3). The posterior extensions of the premaxillaries seldom expand posteriorly as in *albigula*, but are more as in *mexicana* except that they are longer.

INTERORBITAL REGION: The region between the orbits is broader and less depressed than in either *lepida*, *albigula*, or *mexicana*. In some instances, it is difficult to distinguish between *stephensi* and *lepida* on the basis of this character. The supraorbital ridges in *stephensi* tend to remain lateral as they continue forward toward the rostrum, whereas in the other species these ridges approach the midline, ending almost in line with the posterior extensions of the premaxillaries (Fig. 3).

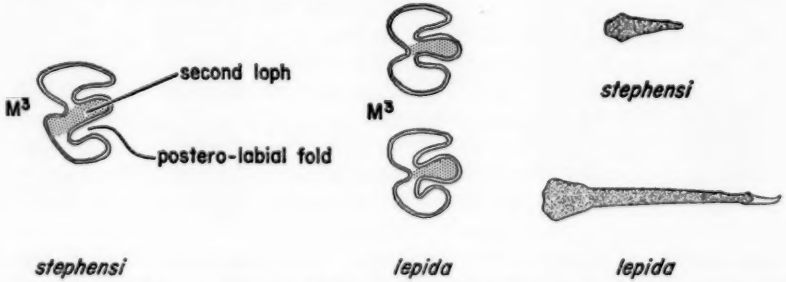

FIG. 1.—Third upper molar (×6.5) and baculum (×2.4) of *Neotoma stephensi* and *Neotoma lepida*.

Of perhaps lesser diagnostic significance when compared with *N. lepida* are the following skull characters: upper incisors strongly recurved; tubercle on outer face of mandible at base of lower incisor hardly noticeable, whereas more nearly knoblike in *lepida*.

External features.—The bushiness of the tail, particularly the terminal third, approaches that of *Neotoma cinerea*. The tail is far more bushy than in any other species within the range of *stephensi*, and probably exceeds that of any wood rat except *cinerea*. In young *stephensi*, only a few weeks old, the tail already is bushy, and specific recognition is possible on this character.

On the hind foot, a wedge of dusky-colored hair may extend onto the dorsal surface as much as one-third the distance to the base of the toes. In most specimens of *N. lepida*, particularly in those races which are not melanistic, the dorsal surface of the foot is whitish, with the dusky color stopping at the tarsal region.

The underparts are suffused with an ochraceous or buffy wash in nearly all specimens. In *N. stephensi stephensi* the throat region also shows this same wash, but the region between the forelegs is whitish. In *N. stephensi relicta*, the wash does not extend onto the throat and thus it is usually white. The coloration of the underparts in *N. s. stephensi* is similar to that in most specimens of the dark races of *N. lepida*, such as *monstrabilis* and *harteri*, and is thus noticeably different than in the light-colored races of the latter species. Where *N. lepida* occurs within the range of *N. stephensi*, nearly all specimens of *lepida* have light-colored underparts and thus this character aids in distinguishing the two.

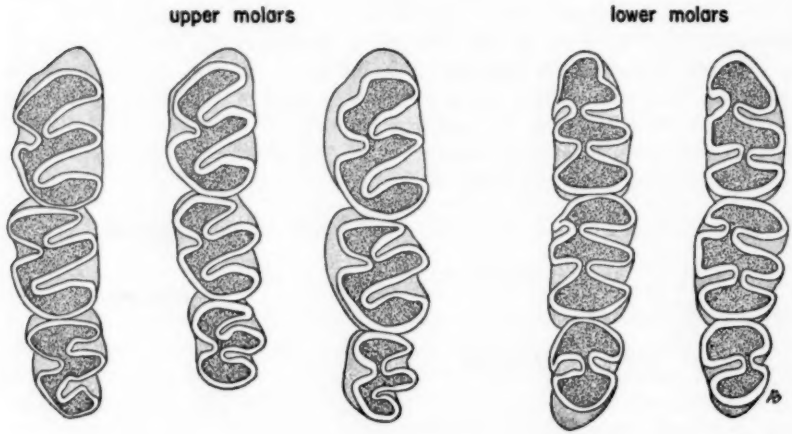

FIG. 2.—Occlusal view of right upper molars of *Neotoma stephensi*, *N. lepida*, *N. albigula*, and left lower molars of *N. stephensi* and *N. lepida* (×6.5).

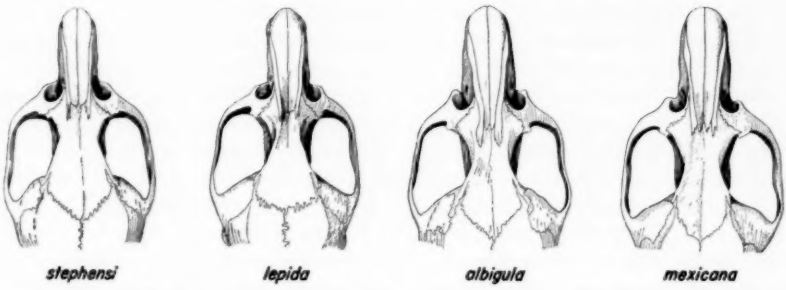

FIG. 3.—Dorsal view of anterior part of skull of *Neotoma stephensi*, *N. lepida*, *N. albigula*, and *N. mexicana* (×1).

VARIATION

Age.—In *N. stephensi*, we can recognize four groups which include young animals, old animals, and two categories between these extremes. These groups are based on the degree of eruption and wear of the upper molar teeth. We attempted to corroborate this grouping by the use of other characters, such as closure of sutures, size and proportion of various parts of the skull, and molt, but these proved to be of little help. Further discussion of the younger groups is given under *Growth and Reproduction.*

GROUP 1. Immatures; M^3 not erupted or in the process of erupting and occlusal surface of posterior loph isolated from that of more anterior lophs.

GROUP 2. Young adults; females, at least, sexually mature. Folds of M^1, as seen laterally, continuing down below alveolus; M^3 fully erupted and occlusal pattern usually complete with posterior loph rarely isolated.

GROUP 3. Adults; folds of M^1 not extending to alveolus, but to or below an arbitrary midpoint between alveolus and occlusal surface.

GROUP 4. Old adults; folds of M^1 very short and not reaching midpoint between occlusal surface and alveolus. Folds may be entirely absent.

Sexual.—Although there is a size difference between males and females, it is less marked in certain age groups. From our sample, we find that in Groups 1 and 2, the sexual difference is slight. In Group 3, males usually average larger than females in most measurements. For example, in specimens from the Hualpai Mountains (6♂♂, 10♀♀), the Grand Canyon (4♂♂, 4♀♀), and Wupatki (4♂♂, 4♀♀), the males are larger than the females by percentages ranging from 1 to 13 in *most* measurements. In all three localities, however, the females average larger than the males in length of maxillary toothrow as follows: Hualpai Mountains, 2.3; Grand Canyon, 1.2; Wupatki, 1.2 per cent. The larger average size of the toothrow in females is also indicated in specimens from other localities. Group 4 is represented by too few individuals to determine sexual differences. Aside from the quantitative differences pointed out, the skull of adult females is characteristically short and broad, in contrast to the long and narrower skull of the males.

No sexual difference in color was apparent.

Color.—The color of an "average" specimen consists of a light buff wash extending from the chest to the inguinal region. The chest is white, with the throat a buffy color with the hair plumbeous basally and buffy-tipped. The white of the chest may extend anteriorly to the chin as a median narrow stripe. The inguinal area is whitish.

The coloration of the underparts, including the buffy wash, throat, and chest color, in any one population, may be highly variable. For example, near Montezuma Well, Yavapai County, Arizona, one specimen has 98 per cent of the underparts heavily washed with a dark buff, one has little or no buff, and one has no white on the chest and throat. Still other specimens from here show varying stages of intermediacy. In other populations, individuals can be found that have the throat entirely white, with the basal portions of the hairs not plumbeous or gray-colored. The whitish throat is "typical" of another, unrelated species—*albigula*. Such occurrences of "white-throatedness" are widely scattered throughout the range of the species, being found in populations from the Hualpai Mountains in the northwest to the Burro Mountains in the southeast.

The extreme of this white-throatedness is found in *N. stephensi relicta*. In this race, nearly all individuals, and probably every adult, have white throats. Within the race *stephensi*, certain populations have most of the adults with white throats. This is true for the populations at Hilltop, west end of Grand Canyon National Park, but is not true for other populations within the Park or for most specimens from the Hualpais. The population from the Burro Mountains, New Mexico, has all of the specimens white-throated. In general, specimens with the entire throat region white have the buffy wash over the abdominal region greatly reduced or entirely lacking. Thus most specimens of *relicta* and specimens of *stephensi* from Hilltop and the Burro Mountains lack the buffy wash.

Variation of the dorsal coloration within a population is less easily observed. The geographical variation of this color, within subspecies, is discussed beyond and illustrated in Plate I.

GROWTH AND REPRODUCTION

In the absence of growth data for *N. stephensi*, we have been guided by previous work in other species of *Neotoma*, especially in *N. albigula* from Arizona (Richardson, Jour. Mamm., 24: 134, 1943). Although two species may well differ markedly in their rate of growth and reproductive patterns due to different heredity and different environmental conditions, we have used the *N. albigula* information to put forth tentative conclusions, leaving it to future work to prove or disprove the validity of our interpretations. We have, thus, assumed that the progress of growth is essentially the same in *N. albigula* from Arizona as it is in *N. stephensi* from that area, and that the gestation period in *N. stephensi* is, as in other species, approximately 30 days

in length. From the growth curve of head and body size in *N. albigula* (Richardson, *op. cit.*), approximate ages and thus dates of birth were calculated for our sample of immature specimens (Group 1) of *N. stephensi.* Table 1 indicates the chronological distribution of Group 1 and Group 2 specimens studied, and the dates of capture of pregnant and lactating females.

The near disappearance of Group 1 individuals following the middle of August, and the clear increase of Group 2 animals from this time on, strongly suggest that Group 2 is a composite group. Group 2 specimens taken in June, July and August most likely are young born late in the preceding year, that is, in August, September and October. Specimens taken in September and October, however, probably represent young of the year, born in the early months following the earliest breeding period.

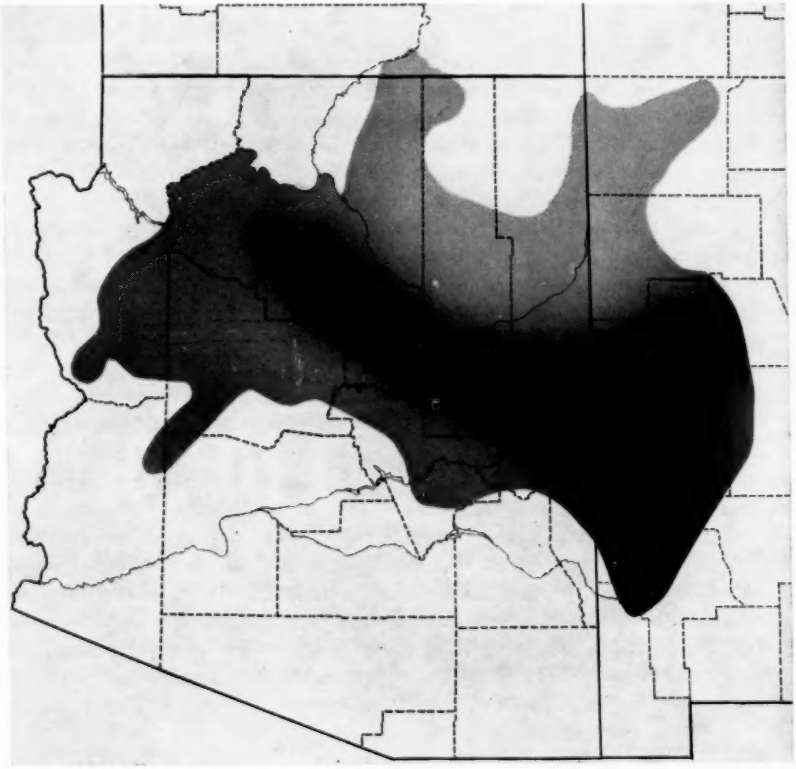

PLATE I

Variation in the intensity of the over-all color in *Neotoma stephensi.* The darkest-colored populations are represented by the darkest area; the lightest, by the lightest area.

TABLE 1.—*Bimonthly distribution of Group 1 and Group 2 individuals, with dates of capture and age of pregnant and lactating females*

Date of Capture		Group 1	Group 2	Pregnant ♀♀	Lactating ♀♀
April	16–30			Apr. 30 (Group 4)	
May	1–15	1	1		
	16–31	1			
June	1–15	3			
	16–30	5	1	June 18 (Group 3)	June 26 (Group 3)
July	1–15	6	8	July 13 (Group 2)	July 15 (Group 2)
	16–31	6	1		
Aug.	1–15	6	5		
	16–30		3		Aug. 22 (Group 4)
Sept.	1–15	1	4		
	16–30	1	11	Late Sept.	
Oct.	1–15		11		

Using the growth rate of *N. albigula* as a guide, the dates of birth of Group 1 individuals begin in early March, and thus mating must begin early in February. The dates of birth appear to form two groups—one including March and April, and the other from the middle of May to the middle of July. This suggests two litters but, if a litter can follow another in a period of 15 days, as has been reported for *N. albigula*, it is quite possible that *N. stephensi* may have more than two litters. The usual litter seems to consist of two young, as indicated by four cases of pregnant females containing two embryos each. It is of interest that one of the pregnant animals taken on 13 July, and a lactating female taken 15 July, were clearly of Group 2. The date of capture, in addition to the age group of these animals, certainly seems to indicate that females reach sexual maturity the second season after birth. These females must have been born in the spring or summer of the preceding year.

HABITAT

Neotoma stephensi occupies an ecological niche quite distinctive from that of *Neotoma lepida*. In our collecting experience, *N. stephensi* is found in rocky situations, usually where the rocks are in piles, and usually where there are piñons and junipers. *Neotoma stephensi* is not a cliff dweller, although it may be found in the general vicinity of cliffs, but is found where the rocks have rolled down and become stacked. However, even though suitable rocks may be present, *N. stephensi* most likely will not be found if piñons and junipers are absent. This wood rat is frequently found associated with the piñon mouse, *Peromyscus truei*, the brush mouse, *Peromyscus boylii*, or the cactus mouse, *Peromyscus eremicus*.

Within Grand Canyon National Park, *Neotoma stephensi* is to be found in several ecological situations. In the majority of places, *N. stephensi* was found in rocky situations where there were piñon, juniper, scrub oak and cliffrose. In these situations, it was usually associated with *Neotoma mexicana*, but in

a few cases, with *N. albigula*. In Long Jim Canyon, *N. stephensi* was in a rocky place within the yellow pine forest. At Cedar Mountain, the species was at the lowest edge of the piñon-juniper belt. Here, on the rocky, desert slopes, there were many cacti and agave plants and only a few straggling piñons or junipers. *N. stephensi* widely overlapped the range of *N. albigula* here. At Hilltop, near the western boundary of the Park, *N. stephensi* was in rocky places decidedly below the piñon-juniper zone and in an area where there were sagebrush, Indian paintbrush and grasses. Here, *Perognathus intermedius, Neotoma albigula, Eutamias dorsalis,* and even *Peromyscus truei* and *P. boylii* were present.

In the vicinity of Rimrock and Montezuma Well in eastern Yavapai County, Arizona, *N. stephensi* was found along the fractured limestone outcrop extending horizontally near the top of the low mesas. This outcrop was 5 to 8 feet in height and was fractured along its length into large blocks. *N. stephensi* occurred in the crevices among these blocks, along with many *Peromyscus eremicus.* Rat houses and piles of droppings were evident all through the outcrop. About 40 feet below the limestone stratum there occurred a short dark lava outcrop which was much more finely fractured. *Neotoma albigula* was found here as well as on the valley floor where it lived among the cacti. No *N. albigula* was taken among the blocks of limestone where *N. stephensi* occurred. These field observations made by John S. Hall suggest an important difference in the habitat preference of *N. stephensi* and *N. albigula,* even in areas where these two species are very near to each other.

At the western edge of the range of *Neotoma stephensi,* in the Hualpai Mountains, it may also occur above the piñon-juniper zone in the scrub oak and yellow pine. However, it was taken in rocky situations and in association with *Peromyscus boylii.*

Occasionally, *N. stephensi* will desert its preferred rocky habitat and move into or under man-made structures. At Pasture Wash, a female with half-grown young was living among bales of hay in the loft of an unused barn. Near McMillen Mine, individuals had homes under large sheets of building material which had been on the ground for a long period of time.

In New Mexico, according to Bailey (N. Amer. Fauna 53: 188, 1931), *N. stephensi* in the Burro Mountains live in "stick nests placed about logs or brush, and in places their burrows entered the ground about the bases of rocks with many sticks piled about the entrances." Bailey stated that they occupy the juniper-piñon plateau region, frequenting rocky places and even cliffs.

Neotoma stephensi Goldman

Range.—Central Arizona, from Hualpai Mountains on the west to western New Mexico on the east, and from McMillenville on the south to extreme south-central Utah (Navajo Mountain) on the north (Fig. 4).

Diagnosis.—A medium-sized species of *Neotoma* with a bushy tail (bushier than in any other species except *N. cinerea*); dusky coloration on dorsal surface of foot extending from ankle nearly one-third distance to base of toes; small baculum, exclamation-mark-shaped (Fig. 1); upper molariform teeth with following combination of characters: M^1 with antero-medial fold absent or poorly developed, and M^3 with postero-labial fold and second loph directed obliquely (Figs. 1, 2); last lower molar with deep lingual fold as deep or deeper than labial fold (Fig. 2); skull broad and flat interorbitally; rostrum narrow; nasals truncate posteriorly (Fig. 3).

Neotoma stephensi stephensi Goldman

Neotoma stephensi Goldman, 1905, Proc. Biol. Soc. Wash., 18: 32, 2 Feb.
Neotoma lepida stephensi, Goldman, 1910, N. Amer. Fauna 31: 80, 19 Oct.
Neotoma stephensi stephensi, Goldman, 1932, Jour. Mamm., 13: 66, 9 Feb.

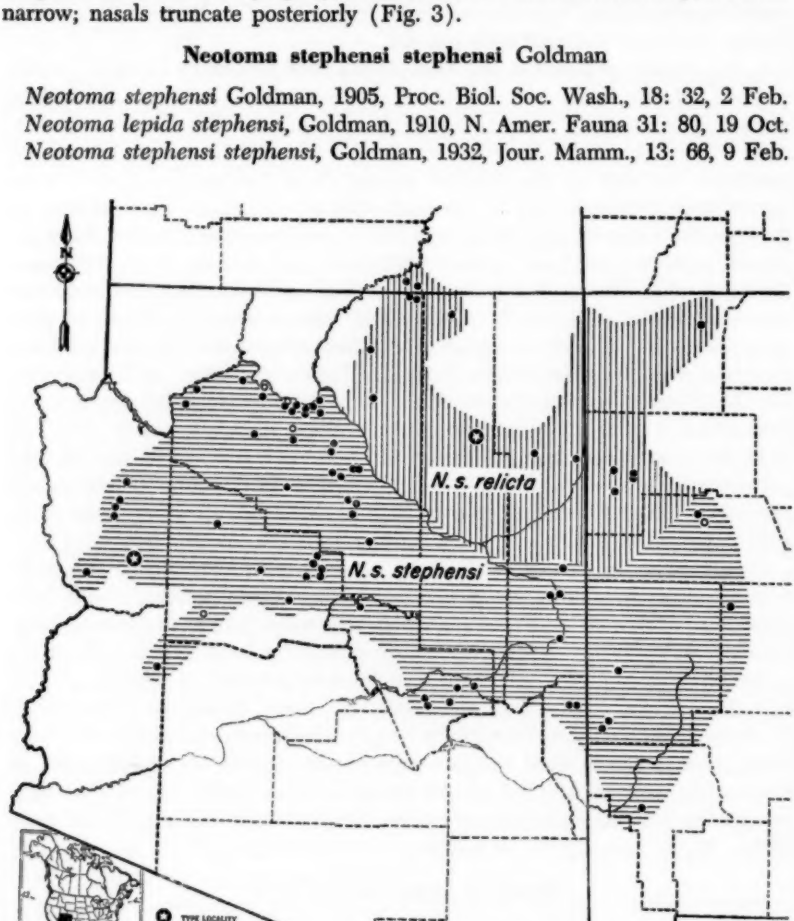

FIG. 4.—Distribution of the subspecies of *Neotoma stephensi*.

Type.—Adult female, U.S. National Museum (Biol. Surv.), No. 117466, from Hualpai Mountains, 6,300 ft., actually at Horse Tank (see *Remarks*), Mohave County, Arizona, collected on 1 July 1902 by Frank Stephens; original no. 4192.

Range.—From the Hualpai, Chemehuevis, and Harquahala mountains in western Arizona east along the Mogollon Plateau to the Burro and Gallinas mountains in southwestern New Mexico (see map, Fig. 4).

Diagnosis.—A race showing considerable variation throughout its range but possessing the following characteristics: color of dorsum dark, being darkest in central Arizona and southwestern New Mexico (Plate I); sides above lateral line with narrow fulvous band near Pinkish Buff; nose, forehead and cheeks grayish or plumbeous; hair of throat usually plumbeous basally; top of tail appears dark, almost black, because more black hairs and few or no white hairs interspersed or show through; size large, as indicated by weight in adult males of usually more than 180 grams; skull large, usually averaging more in greatest length than 41.2 mm. in adult males; upper toothrow long, usually 8.4 mm. or more; skull with supraorbital ridges frequently beaded and heavy.

Comparisons.—Since there is considerable variation within the subspecies *stephensi*, groups of populations of this race have been compared with the relatively homogeneous "population" of *relicta*.

From *relicta*, the race *stephensi* from the Hualpai Mountains, Hackberry, Harquahala Mountains, and Grand Canyon National Park differs as follows: darker coloration (but less different than in other populations of *stephensi*); more grayish nose, forehead and cheeks; not "white-throated" except for specimens from Hilltop; markedly heavier in weight; broader skull, both actually and relatively to its length (especially marked in specimens from the Hualpai Mountains); longer toothrow and broader interorbitally (especially in specimens from the Hualpais).

Central Arizona populations (for discussion, see under *Remarks*) differ from *N. s. relicta* as follows: color markedly darker, both on the dorsum and sides; dorsal tail stripe more blackish, less gray; body-weight, length of toothrow, and interorbital width greater, but not so pronounced as in topotypes of *stephensi* from the Hualpai Mountains; differ from *relicta* in other features the same way as do topotypes of *stephensi*.

Populations from eastern Arizona and southwestern New Mexico differ from *N. s. relicta* as follows (for discussion, see under *Remarks*): color darker, including facial region, sides and tail; throat tending to be partially or entirely white (in the latter case showing similarity to *relicta*); externally larger and heavier; skull with nasals broad, tending to be bell-shaped anteriorly, but constricted posteriorly; ascending arms of premaxillaries broader; differ from *relicta* in other features as do topotypes of *stephensi*.

Measurements.—See Tables 2 and 3.

Remarks.—As mentioned under *Comparisons*, there is considerable varia-

TABLE 2.—*External and cranial measurements of "Group 3" male specimens of Neotoma stephensi stephensi. Grouped localities are as follows: Western Arizona (Hackberry, Hualpai Mts., Lucky Star Mine); Northern Arizona (Grand Canyon); Central Arizona (Red Lake, Wupatki area); Southeastern Arizona (McMillenville area, Nantanes Plateau, Black River); Western New Mexico (Burley, Burro Mts., Glenwood)*

	Western Arizona	Northern Arizona	Central Arizona	Southeastern Arizona	Western New Mexico
Number	8	4	6	3	4
Total length	301.2	311.2	314.0[4]	308.3	298.3[8]
	283.0–334.0	305.0–320.0	303.0–320.0	302.0–313.0	290.0–310.0
Head and body	173.6	175.8	183.2[4]	174.0	169.5[8]
	161.0–201.0	172.0–178.0	171.0–203.0	165.0–182.0	165.0–177.0
Tail	127.6	135.0	132.7[4]	134.3	127.3[8]
	120.0–135.0	127.0–144.0	125.0–138.0	131.0–137.0	120.0–133.0
Hind foot	32.3	31.5	32.7	31.7	31.6
	31.0–34.0	29.0–34.0	32.0–34.0	31.0–32.0	30.0–33.0
Condylobasal length	39.5[7]	39.7	40.0	38.6	37.3
	37.6–41.5	39.3–40.1	37.7–42.5	37.7–39.3	36.5–39.2
Zygomatic breadth	22.1[7]	21.2	21.3[5]		20.4[8]
	21.0–23.0	20.6–21.8	20.6–21.9	21.0[1]	20.2–20.8
Interorbital	5.7	5.4	5.5	5.5	5.3
	5.6–6.0	5.1–5.7	5.3–6.0	5.4–5.6	5.0–5.6
Breadth of rostrum	6.5	6.4	6.1	6.5	6.1
	5.9–6.9	6.3–6.5	5.9–6.4	6.2–7.0	5.6–6.5
Depth of rostrum	6.8	6.9	6.8	6.7	6.3
	6.5–7.0	6.8–7.1	6.5–7.1	6.4–7.1	6.1–6.5
Nasal	15.5	16.0	16.3	16.0	15.1
	15.0–16.2	15.4–16.8	15.7–17.5	15.8–16.3	14.1–16.8
Incisive foramen	9.1	9.0	9.5	8.7	8.4
	8.8–9.5	8.8–9.4	9.0–10.2	8.2–9.2	8.0–9.0
Palatal bridge	7.6	7.5	7.5	8.1	7.7
	7.4–7.9	7.3–7.6	7.0–7.7	7.9–8.4	7.5–7.9
Maxillary toothrow	8.7	8.3	8.5	8.9	8.6
	8.3–9.3	8.1–8.6	7.9–9.0	8.7–9.2	8.4–8.8

tion within the subspecies *N. s. stephensi* as here delimited. This variation can be discussed by grouping the populations into three segments, from (1) the Hualpai Mountains, including others from western Arizona and the Grand Canyon region, (2) central Arizona, and (3) eastern Arizona and western New Mexico. We prefer to describe these three "variants" but not to give them names.

The first group of populations in western Arizona possesses the following characteristics: light color (see Plate I); long toothrow, broad across zygomatic arches, broad interorbitally, yet skull is only of average length; large foot, average length of body, and short tail. Within this group of populations, those specimens from the type locality (Hualpai Mountains) have certain unique features such as relatively short but broad skulls, long toothrows, broad interorbital regions, greater weight, and slightly paler than "average" coloration for the subspecies. If only topotypes are used for comparison with other

populations of *N. stephensi*, the impression may be gained that the population is quite distinct. However, when the range of variation in all characters from throughout the geographic range of *stephensi* is taken into consideration, the differences are less impressive and not as significant. In many features, topotypes of *stephensi* are not "typical" or "average" for the race.

In central Arizona, there is a series of populations of *N. stephensi* which possesses characteristics of an average difference distinguishing it from neighboring populations. This series, depicted by the dark area in Plate I, comprises populations from Black Tank to the north, south through Deadman's Flat, Wupatki Monument, Winona, Walnut, Verde Valley, and west to Red Lake and Fort Whipple. Specimens from as far south as McMillenville and the Natanes Plateau in Gila County are not included. This complex of populations possesses the following features, many of which are of an average sort: color dark; dorsal tail stripe often black; sides with the ochraceous color along the lateral line greatly restricted; body long, as long or longer, on the average, than in any population; body weight intermediate between that of *relicta* and

TABLE 3.—*External aand cranial measurements of "Group 3" female specimens of Neotoma stephensi stephensi. Grouped localities are as in Table 2*

	Western Arizona	Northern Arizona	Central Arizona	Southeastern Arizona
Number	12	5	5	3
Total length	274.2	298.3[6]	309.8[4]	
	264.0–329.0	279.0–323.0	293.0–322.0	304.0[1]
Head and body	170.1	168.3[6]	175.0[4]	
	148.0–195.0	160.0–180.0	173.0–179.0	164.0[1]
Tail	129.0	130.0[6]	134.8[4]	
	106.0–141.0	119.0–143.0	118.0–148.0	140.0[1]
Hind foot	32.0	31.3[6]	33.3[4]	
	30.0–34.0	30.0–32.0	33.0–34.0	32.5[1]
Condylobasal length	38.8[11]	36.6	38.6	38.8[2]
	36.8–40.7	35.9–37.5	38.0–39.7	38.2,39.3
Zygomatic breadth	21.8[8]	20.7	20.7	21.6
	21.1–23.2	20.4–20.9	20.5–20.9	21.2–22.0
Interorbital	5.4	5.4	5.4	5.7
	4.7–5.8	5.2–5.7	5.0–5.7	5.3–6.0
Rostrum breadth	6.3	5.9	6.3	6.4[2]
	6.0–6.6	5.6–6.0	6.1–6.5	6.3,6.5
Rostrum depth	6.6	6.1	6.5	6.7[3]
	6.2–7.0	5.5–6.2	6.4–6.7	6.5,6.8
Nasal	15.3	14.3	15.7	15.5[2]
	13.9–16.6	13.7–14.6	15.3–16.3	14.9,16.1
Incisive foramen	8.5	8.4	9.1	8.7[3]
	7.9–8.8	8.1–8.8	8.5–9.5	8.5,8.9
Palatal bridge	7.6	7.2	7.2	7.8
	6.9–8.5	6.9–7.9	6.5–7.5	7.5–8.5
Maxillary toothrow	8.9	8.4	8.6	9.0
	8.4–9.5	8.1–8.8	8.5–8.8	8.6–9.3

specimens from the Hualpai Mountains; skull long and narrow, with the percentage of zygomatic breadth to greatest length in adult males being between 48.4 and 50.4; for the Hualpais, 51.7 to 53.6; for the Grand Canyon, 49.7 to 51.4; similar percentages for adult females from the respective localities are between 49.2 and 53.8; 50.8 to 54.8; 51.6 to 53.5. The length of the upper toothrow and width of the interorbital region are intermediate between *relicta* and specimens from the Hualpai Mountains.

Although this complex of populations may possess some average differences of color and size, we feel that it has not reached the subspecific stage of differentiation.

In western New Mexico and eastern Arizona, there is a group of populations that has certain characters in common, and differs in an average way from *N. s. stephensi* in western Arizona. This group includes localities from 25 mi. N Springerville and from Springerville in Arizona southeast to the Burro Mountains, New Mexico, and northeast to Grants. Some features of this group, many of which are not diagnostic, include: nasals broad, almost bell-shaped anteriorly; posterior arms (ascending branches) of premaxillae on dorsum of skull broad; nasals, posteriorly, constricted more by premaxillae than in most other populations; color dark, as dark as that in central Arizona populations except for specimens from Burley. For remarks about the white-throatedness of specimens from the Burro Mountains, see page 480. One specimen from Grants, Catron County, New Mexico, in many ways exemplifies the extreme of these characters listed: nasals bell-shaped anteriorly, constricted posteriorly; posterior, ascending arms of premaxillae broad; interorbital region broad; color dark, with the addition of a heavy, rich fulvous wash over the entire underparts. This specimen lacks 90 per cent of the tail, and our first reaction was that this specimen was not a bushy-tailed *Neotoma stephensi*. The heavy wash of fulvous on the underparts is duplicated in one of three specimens of *Neotoma mexicana* from 5 mi. SE Grants. However, careful analysis, particularly of cranial features, indicates that the specimen is *N. stephensi*, not *N. mexicana*. This individual is either aberrant or reflects the extreme characters of this group of populations we have described above. We prefer the latter interpretation. The fulvous wash on the underparts may reflect the "influence" of the black lava near Grants. We do not think this fulvous wash represents a "dichromatic condition" that Goldman (N. Amer. Fauna 31: 81, 1910) alluded to, although more specimens may indicate that such is the case. A specimen from 4 mi. W McCartys, which is near Grants, is a very young animal and shows none of the features of the Grants' specimen.

According to Laurence Huey, the type locality should be regarded as Horse Tank at the southern end of the Hualpai Mountains. Mr. Huey informs us that Frank Stephens provided him with this information.

Specimens examined.—Total number, 163, from the following localities: ARIZONA—*Mohave County:* Hackberry, 7 (BS); Democrat Mine, 13 mi. ESE Kingman, Hualpai Mts., 1 (UI); Hualpai Mtn. Park, Hualpai Mts., 1 (UI); 1 mi. N Hualpai Peak, Hualpai Mtn.

Park, 7,000 ft., 1 (UI); Pine Lake, Hualpai Mtn. Park, 6,000 ft., 1 (UI); Hualpai Mts., 5,600 ft., 7,000 ft., 6 (BS), 1 (UI); Horse Tank, 5 (SD); Lucky Star Mine, Chemehuevis Mts., 3 (SD); *Yuma County:* Harquahala Mts., 5,000 ft., 3 (BS); *Coconino County:* Hilltop, S side GCNP [= Grand Canyon Nat. Park], 4 (UI); Lower end Prospect Valley, 5,200 ft., 2 (BS); Pasture Wash Ranger Station, 6,300 ft., GCNP, 3 (UI); Pasture Wash, Jct. rds. W9A & W9, GCNP, 1 (UI); 8 mi. N Pine Spg., Hualpai Indian Reservation, 3 (BS); E side Cedar Mt., 6,400 ft., GCNP, 2 (UI); Yaki Burn, S rim Grand Canyon, 2 (GC); Yavapai Point Station, S rim Grand Canyon, 3 (GC); Grand Canyon Village, S rim Grand Canyon, 1 (GC); S rim Grand Canyon, 1 (GC); S boundary GCNP, nr. Rowes Well, GCNP, 1 (UI); School athletic grounds, Village, GCNP, 7 (UI); Shoshone Point, GCNP, 2 (UI); Wayside Museum, S rim Grand Canyon, 1 (GC); 1 mi. E, ½ mi. S Desert View Pt., GCNP, 1 (UI); Grandview Pt., GCNP, 1 (UI); Long Jim Canyon, 3 (UI); W side Zuni Pt., 7,200 ft., GCNP, 6 (UI); Rt. 64, SE Boundary GCNP, 1 (UI); Cataract Canyon, 12 mi. WSW Anita, 2 (BS); Red Butte, 2 (BS); Black Tank Lava Beds, 6,100 ft., 3 (UC); Lava Field, 12 mi. N Deadman's Flat, NE San Francisco Mt., 1 (UC); 2.6 mi. W Wupatki Ruins, 8 (UC); Wupatki Indian Ruins, 35 mi. NE Flagstaff, 5,100 ft., 1 (BS), 6 (UC); Deadman's Flat, NE San Francisco Mt., 6,400 ft., 2 (UC); 4 mi. NE Deadman Ranger Station, San Francisco Mt., 6,600 ft., 1 (BS); Red Lake, 5 (BS); 3 mi. NW Winona, 6,200 ft., 6,400 ft., 2 (BS); Aztec Tank, 5,800 ft., 2 (BS); Winona, 6,400 ft., 2 (UC); Walnut, 1 (BS); Walnut Canyon, 5 mi. S Mt. Elden, 6,500 ft., 1 (BS); Anderson Mesa, Anderson Canyon, 30 mi. SE Flagstaff, 6,500 ft., 1 (BS); *Yavapai County:* Pine Flat, Juniper Mts., 20 mi. NW Simmons, 3 (BS); 5 mi. S, 1 mi. W Sedona, 1 (UI); 2 mi. N Montezuma Well, 3 (UI); 2 mi. N Rimrock, 1 (UI); Montezuma Well, 3,500 ft., 2 (BS); 3 mi. N Ft. Whipple, 1 (BS); 6 mi. NW Camp Verde, 1 (UI); Mayer, 1 (BS); *Gila County:* 7 mi. N Payson, 4,500 ft., 1 (BS); Black River, 5 mi. above mouth White River, 4,600 ft., 1 (BS); nr. sawmill, 25 mi. NE Rice [now San Carlos], Natanes Plateau, 5,800 ft., 3 (BS); McMillen Mine, 5 mi. E, 12½ mi. N Globe, 4 (UI); Cazador Spring, S base Natanes Plateau, San Carlos Indian Reservation, 4,000 ft., 1 (BS); McMillenville, 4,300 ft., 3 (BS); *Apache County:* Zuni River, 3 (BS); 8 mi. S St. Johns, 5,800 ft., 4 (BS); 25 mi. N Springerville, 2 (BS); Springerville, 7,000 ft., 1 (BS); *Greenlee County:* 3 mi. W Cosper Ranch, 6,000 ft., 1 (BS); Cosper Ranch, Blue River, 5,000 ft., 2 (BS); NEW MEXICO—*Valencia County:* Grants, 1 (BS); 4 mi. W McCartys, 1 (UM); *Socorro County:* Burley [22 mi. N Augustine], 3 (BS); *Catron County:* Largo Canyon, 1 (UC); Whitewater Canyon, 5 mi. NE Glenwood, 5,450 ft., 1 (AM); Glenwood, San Francisco Valley, 5,000 ft., 1 (BS); *Grant County:* Burro Mts., 8 (BS).

Additional records.—ARIZONA—*Coconino County:* S side Bass Camp, 8 mi. NW Grand Canyon (BS); 1 mi. N Bass Camp, 5,200 ft., (BS); 3 mi. S Bass Camp, 5,400 ft., (BS); Bass Camp (BS); nr. Bright Angel Trail, Grand Canyon, (BS); S Yaki Point, in yellow pine, Grand Canyon (BS); top of rim nr. Village, Grand Canyon, 6,800 ft., (BS); Grand View Point, Grand Canyon, (BS); Trash Tank, S rim Grand Canyon, (GC); Trash Wash, S rim Grand Canyon, (GC); N Red Butte, Main Road, Grand Canyon, (BS); Red Butte, Museum of Northern Arizona; Wupatki Nat'l Monument, 5,100 ft., Museum of Northern Arizona; Wupatki Indian Ruins, 35 mi. NE Flagstaff, 5,100 ft., (BS); *Yavapai County:* Fools Gulch, Weaver Mts., (BS).

Neotoma stephensi relicta Goldman

Neotoma stephensi relicta Goldman, 1932, Jour. Mamm., 13: 66, 9 Feb.

Type.—Adult female, U.S. National Museum (Biol. Surv.), No. 67780, from Keams Canyon, Navajo County, Arizona, collected on 22 July 1894 by A. K. Fisher; original no. 1649.

TABLE 4.—*External and cranial measurements of "Group 3" specimens of Neotoma stephensi relicta. Localities represented are as follows: Utah—Navajo Mt., Rainbow Bridge; Arizona—Rainbow Lodge, Cedar Ridge, Keams Canyon; New Mexico—Wingate area, Long Canyon, Blanco*

	Females	Males
Number	10	10
Total length	296.7[a]	304.7[a]
	273.0–320.0	283.0–333.0
Head and body	163.0[a]	172.0[a]
	153.0–175.0	159.0–187.0
Tail	133.7[a]	130.9
	120.0–145.0	123.0–144.0
Hind foot	30.4[a]	31.2
	28.0–33.5	29.0–33.0
Condylobasal length	36.3[a]	37.8[a]
	33.7–38.0	36.8–38.6
Zygomatic breadth	20.0[a]	20.5[a]
	18.4–20.2	20.0–21.1
Interorbital	5.2	5.3[a]
	4.8–5.7	5.2–5.4
Breadth of rostrum	5.9	6.0[a]
	5.5–6.3	5.5–6.4
Depth of rostrum	6.2	6.6
	5.8–6.5	6.4–7.0
Nasal	14.7[7]	15.4
	13.5–15.8	14.9–16.0
Incisive foramen	8.4	8.8
	7.8–9.0	8.5–9.4
Palatal bridge	7.2	7.4
	6.7–7.8	7.1–7.9
Maxillary toothrow	8.1	8.2
	7.7–8.3	7.9–8.4

Range.—East of the Colorado River, from Navajo Mountain in extreme south-central Utah, south to the Little Colorado River, and eastward in New Mexico to the San Juan Basin at the north and the Zuni Mountains at the south (see map, Fig. 4).

Diagnosis.—A race of *Neotoma stephensi* characterized by markedly pale buffy color, with much less blackish and brownish than in other populations of species; sides, above lateral line, with large extent of buffy color, which varies between Pinkish Buff and Light Ochraceous-Salmon; nose, forehead and cheeks buffy, less plumbeous than other subspecies; hairs on throat usually white throughout (base not plumbeous); top of tail appears grayish because few dark hairs present; underparts usually without fulvous wash; size small, being best indicated by light weight (adult males less than 117 gms.); skull small, greatest length averaging less than 41.2 mm. in adult males; upper toothrow short, usually less than 8.4 mm.; skull narrow, with interorbital width usually 5.3 mm. or less and narrow across zygomata, with males usually

averaging less than 21.0 mm.; skull delicate for the species, with supraorbital ridges not heavily beaded.

Comparisons.—For a comparison with *N. stephensi stephensi*, and the geographic variants within that subspecies, see the account of *N. s. stephensi*.

Measurements.—See Table 4.

Remarks.—*N. s. relicta* is a pale race inhabiting the mountainous areas of the elevated, short grass region of northeastern Arizona. The race does extend into New Mexico and Utah, but its principal center of distribution is in Arizona.

N. s. relicta is quite distinctive from many populations of *N. s. stephensi* adjacent to its range. It is less distinctive from some other populations farther removed. However, with a combination of characters (principally on the basis of color), *relicta* and *stephensi* can be distinguished. As here delimited, *relicta* shows less morphological variation geographically than does *stephensi*. Specimens from the eastern part of Grand Canyon National Park, referred to *stephensi*, show considerable approach toward specimens from Cedar Ridge, referred to *relicta*. These two localities are less than 45 miles apart. The intermediacy is in color and, to some extent, size of the skull. Specimens from Wingate and Gallup are of a color intermediate between that of *relicta* and *stephensi*, but the skulls of the adult specimens seem more as in *relicta*, to which subspecies they are referred.

Specimens examined.—Total number, 62, from the following localities: UTAH—*San Juan County:* Rainbow Bridge, 4,000 ft., 1 (UC); nr. War God Spring, 8,500 ft., Navajo Mt., 1 (AM); Navajo Mt. Trading Post, SE side Navajo Mt., 1 (UC); ARIZONA—*Coconino County:* Rainbow Lodge, Navajo Mts., 6,400 ft., 2 (BS); 5 mi. S summit, Navajo Mt., 1 (UC); Cedar Ridge, 30 mi. N Tuba, 3 (BS); Cedar Ridge, 6,000 ft., 10 (UC); Tuba, 1 (BS); *Navajo County:* Long Canyon, 6,450 ft., 1 (AM); Keams Canyon, 80 mi. N Holbrook, 20 (BS); Keams Canyon, 6,200 ft., 6 (UC); *Apache County:* Ganado, 6,500 ft., 5 (BS); St. Michaels, 7,000 ft., 2 (BS); NEW MEXICO—*San Juan County:* Blanco, 1 (BS); *McKinley County:* Gallup, 1 (BS); Wingate, 2 (BS); Fort Wingate, 3 (BS); 12 mi. S Gallup, 1 (BS).

Museum of Natural History, Univ. of Illinois, Urbana. Received 18 August 1959.

THE PENIS OF *SCOTINOMYS LONGIPILOSUS* AND A SECOND SPECIMEN FROM COSTA RICA

By Andrew Starrett

On 24 July 1957, I collected an adult male long-tailed *Scotinomys* at approximately 8,700 feet on the southwestern slope of Volcán Turrialba, Cartago Province, Costa Rica. This animal was shot, with .22 caliber dust shot, as it wandered about on the ground near the base of a tree in full daylight (11:00 AM). The general area is one of cloud forest, somewhat modified by clearing for pasturing dairy cattle. The mouse was taken on a steep slope near the edge of natural forest in a portion of this cleared area which had been fenced off from cattle for some time. Here the ground cover consisted chifely of bunch grass, some of which stood 6 to 8 inches tall.

In general features the Turrialba *Scotinomys* agreed most closely with the description of *S. longipilosus* Goodwin (1945). A comparison of this specimen with the type of *S. longipilosus* at the American Museum of Natural History, kindly made by George G. Goodwin, confirmed this identification. The type and only previously known specimen of this species came from cloud forest at 9,400 feet on Volcán Irazú, the summit of which is about 6 miles west-southwest of that of Volcán Turrialba. The upper portions of the two volcanoes are connected by a saddle in which the elevation does not extend below 7,000 feet. Some measurements of the Turrialba specimen (No. 105657, skin and skeleton, mammal collection, Museum of Zoology, University of Michigan), in millimeters, are as follows: total length, 152; tail length, 79; hind foot, 19; ear from notch, 14; greatest length of skull, 22.9+ (skull damaged by shot); length of nasals, 9.1; zygomatic width, 11.6; least interorbital width, 4.6; length of palatine slits, 4.2; width across upper second molars, 5.1; length of upper alveolar tooth row, 4.5. A comparison of these measurements with those published for the type (Goodwin, *op. cit.*) shows that the specimen from Volcán Turrialba is somewhat larger. Goodwin (*in litt.*) makes note of this fact, although "the type is an adult male with worn teeth and apparently an older specimen" than the one reported on here. He also mentions that the skull of the type, although similar in general characters, is "larger with a noticeably larger, fuller and wider braincase, wider palate and smaller bullae" than that of the Turrialba animal. In pelage color the two specimens are about the same, although the specimen from Turrialba is "more brownish about the cheeks."

Along the midventral line of the body of the freshly killed animal was a conspicuous, narrow, almost hairless area which extended from just anterior to the base of the penis to the level of the posterior end of the sternum. Although no histological examination has been made of the skin in this bare area, its striking similarity to the midventral gland found on some male *Peromyscus maniculatus* (cf. Richmond and Roslund, 1952) suggests that it is also a glandular region. No secretion was apparent in this area on the fresh specimen.

The testes of the animal were inguinal, not descended into the scrotum, and measured 4 × 5 mm.

Penis.—The glans penis of *Scotinomys longipilosus* is a slightly subcylindrical structure, 4.1 mm. long, with fairly regularly spaced minute papillae covering the surface (Fig. 1, *B–D*). The diameter at its distal end is greater than at its base, and its lateral and dorsal surfaces flare out gently in two steps. Its ventral surface is almost straight in profile and is a little shorter than its dorsal surface. The distal end of the glans has in it a shallow crater-like depression, the rim of which is irregularly broken up by shallow indentations. From the center of the depression rises a weakly tricuspidate protuberance which projects beyond the rim of the "crater" and in the center of which is located the urethral orifice. The dorsalmost cusp of this protuberance supports a papilla which contains the cartilaginous tip of the baculum. The baculum is 3.8 mm. long and extends the entire length of the glans, lying just dorsal to the urethra (Fig. 1, *A*). Its dorsal end is firmly anchored in the tip of the glans, as mentioned above, and its base has extremely tough connective tissue attachments to the distal ends of the corpora cavernosa penis. The bone (Fig. 1, *E–G*) consists of a narrow shaft and a laterally expanded proximal portion or base. The base, 0.9 mm. in greatest width, comprises about one-third of the length of the baculum and tapers gradually into the shaft. It contains in its ventral surface a depression for the passage of the urethra. The shaft is slightly dorso-ventrally flattened near the base and becomes essentially cylindrical for the last (distal) two-thirds of its length. The tip of the bone is expanded into a slight knob which is covered by the base of a further expanded cartilaginous projection. From the ventral aspect the entire baculum is quite straight except for the distal end of the shaft which twists slightly to the right. The lateral view shows slight undulations along the bone with the proximal end of the base tipped slightly dorsally and the distal portion of the shaft curved markedly in that direction.

A comparison of the baculum of *Scotinomys longipilosus* with published descriptions of the bacula of other New World cricetine rodents shows the greatest resemblance to be between this species and those of the North American genera *Peromyscus, Ochrotomys, Baiomys* and *Reithrodontomys* (Blair, 1942). Similarities in the shape and proportions of the bone are most noticeable in comparisons of *Scotinomys* with *Ochrotomys* and with *Peromyscus eremicus* and *P. crinitus* (Blair, *op. cit.*). Clark (1953) demonstrated the presence of a simple cartilaginous extension of the baculum, such as is seen in *Scotinomys,* in several species of *Peromyscus,* and Hooper (1958) has shown these "tips" to be characteristic of the genus as a whole, although varying in size among the species. The glans of *Scotinomys longipilosus,* when compared with descriptions of this structure in various species of *Peromyscus* (Hooper, *op. cit.*), shows the greatest similarity to the type of glans found in the species of the "Eremicus Division." A lack of adequate descriptions of

the phallic structure in other New World cricetine rodents makes further comparisons impossible at present. The baculum of *Scotinomys* differs in most essentials (as do the bacula of other genera mentioned above) from the tridentiform structures found in the sigmodont and oryzomine rodents as represented in the literature by a few species of *Sigmodon* Hamilton, 1946), *Oryzomys* (Didier, 1953; Hamilton, *op. cit.*) and *Neacomys* Lawrence, 1941). These comparisons suggest closer relationship between *Scotinomys* and the northern *Peromyscus*-like cricetines than between this genus and the tropical sigmodont and oryzomine groups. Obviously, the male phalli of many more

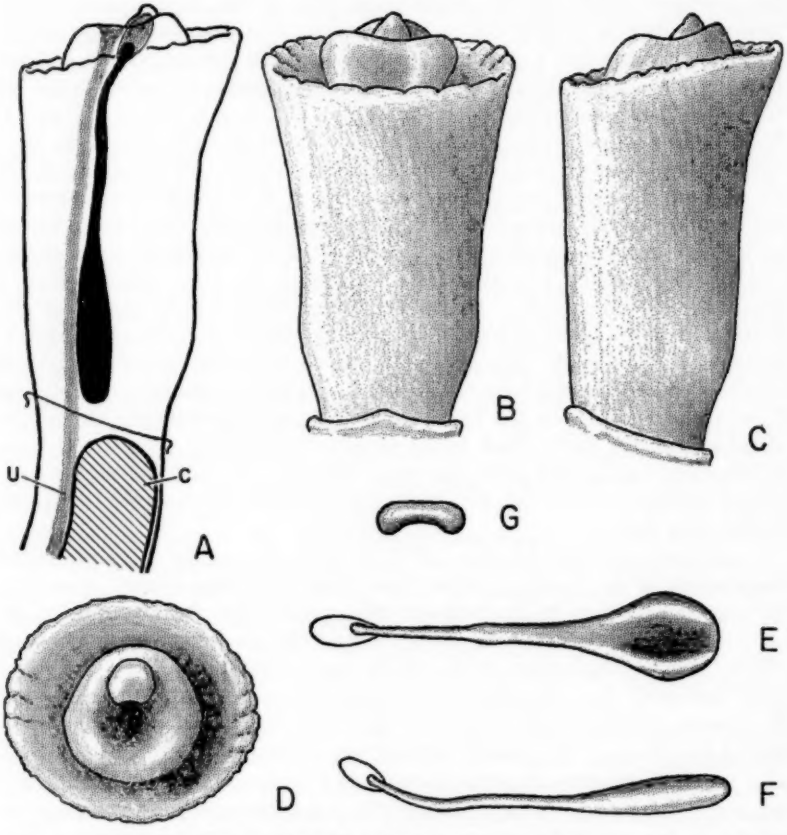

FIG. 1.—The glans penis and baculum of *Scotinomys longipilosus* Goodwin. *A*, Lateral view of glans showing positions of baculum, urethra and corpora cavernosa (ventral to left); *B–D*, ventral, lateral and distal views of glans; *E–G*, ventral, lateral and proximal views of baculum. U—*urethra*, C—*corpus cavernosum penis*. The papillae have been omitted in *B* and *C*.

tropical genera, including some of the akodont rodents, must be compared before any conclusions may be drawn.

I wish to express my appreciation to George G. Goodwin, American Museum of Natural History, for comparing the specimen from Volcán Turrialba with the type of *S. longipilosus*, and to William H. Burt and Emmet T. Hooper, Museum of Zoology, University of Michigan, for providing me with the cleared and stained penis of this animal for description.

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THE BACULUM OF *DIPODOMYS ORNATUS* AND ITS IMPLICATION FOR SUPERSPECIFIC GROUPINGS OF KANGAROO RATS

By William Z. Lidicker, Jr.

The most extensive report on the baculum (*os penis*) of the species of *Dipodomys* is that by Burt (1936). He reported on 41 specimens representing ten species, and concluded that three recognizable groups were present in the material. Burt did not have bacula available to him from the 11 other currently recognized species of *Dipodomys*. Recent collections by the author in the Mexican state of Aguascalientes have made possible the description of the baculum of the little known species *Dipodomys ornatus*. Grinnell (1922) was the first to make phylogenetic groupings of the species of kangaroo rats. He apparently considered his groupings to be at the

superspecies level as he felt that *Dipodomys* contained no distinguishable subgenera. All subsequent revisions of these groupings (see Lidicker, 1960, for a summary of these arrangements) have apparently followed this philosophy. Since it is felt that knowledge of bacular morphology may contribute to our understanding of the phylogenetic relationships among species of kangaroo rats, these new data are explored for any implications relevant to the relationships between, and the composition of, the various species groups. Data for species other than *ornatus* are taken primarily from Burt (1936).

This report is based upon an examination of six bacula from specimens of *D. ornatus* collected in July 1958 in the state of Aguascalientes. Five of the six individuals were considered to be adult, on the basis of tooth wear, translucence of the auditory bullae, and pelage features. The sixth individual (MVZ No. 123068) is definitely younger than the rest and could be called a young adult. The bacula were prepared for examination by placing each dried phallus in 4 per cent KOH until cleared; they were then placed in a .002 per cent solution of Alizarin Red S. When staining had been completed, they were passed in three stages through increasing concentrations of glycerine, and finally stored in 100 per cent glycerine. This technique maintains the baculum intact and undamaged within the fleshy parts of the penis. It also clearly demonstrates that the base of the baculum is hollow in many individuals (see Fig. 1). These vacuities are not evident in bacula which are dissected out and dried. Although previous descriptions have not mentioned hollows in the baculum base, probably because of differing preparatory techniques, it seems likely that such a condition would be found frequently in bacula with large bases.

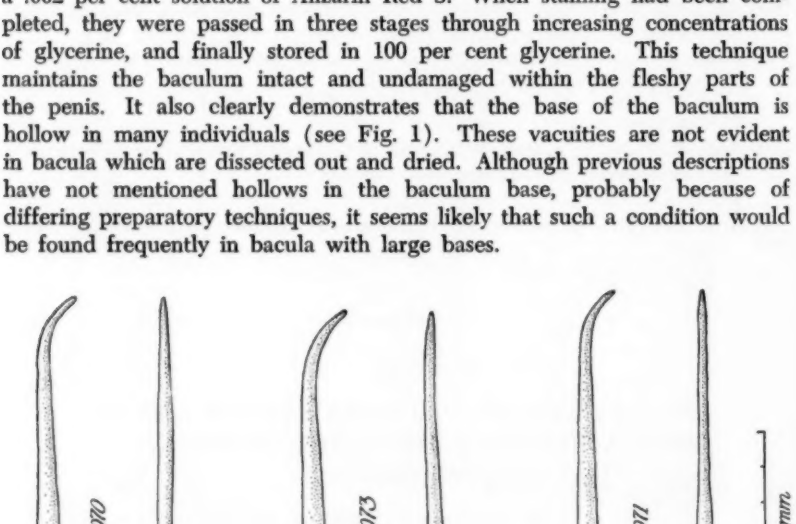

FIG. 1.—Lateral (left) and ventral (right) views of cleared and stained bacula of *Dipodomys ornatus*. Numbers refer to MVZ catalog.

TABLE 1.—*Measurements (in mm.) of bacula and body length of Dipodomys ornatus*

MVZ catalog no.	Length of baculum	Dorso-ventral diam. of baculum base	Lateral diam. of baculum base	Dorso-ventral/ lateral diam. baculum base	Dorso-ventral diam. at mid-shaft	Body length	Body length/ baculum length	Index of robustness†
123067	11.69	1.38	1.46	0.95	.62	106	9.07	24.3
123068*	9.84	1.15	1.00	1.15	.46	101	10.26	21.8
123070	12.69	2.15	1.85	1.16	.62	118	9.30	31.5
123071	12.84	1.61	1.69	0.95	.62	113	8.80	25.7
123072	11.69	2.15	1.61	1.34	.69	121	10.35	32.2
123073	12.23	1.92	1.54	1.25	.77	104	8.50	28.3
average*	12.23	1.84	1.63	1.13	.66	112.4	9.20	28.4

* Averages do not include No. 123068 which is a younger individual.

† (Dorso-ventral diameter of baculum base + lateral diameter of baculum base) × 100/length of baculum.

Measurements were made of the six bacula with the aid of an ocular micrometer, and illustrations were prepared with the aid of a camera lucida. The following measurements were recorded for each baculum: total length, dorso-ventral diameter of the baculum base, lateral diameter of the baculum base, and dorso-ventral diameter of the shaft midway between the ends. These data are presented in Table 1 along with body length, body length divided by baculum length, and an index of robustness (dorso-ventral diameter of the base + lateral diameter of the base × 100/total length of the baculum).

The baculum of *Dipodomys ornatus* is relatively large and somewhat variable in morphological detail (Fig. 1, Table 1). The large basal end is nearly round in cross section, often has irregular tuberosities on its surface, and generally seems to develop large vacuities in older individuals. The shaft tapers gradually and terminates in an abruptly downward curving point. Comparisons with other species are handicapped by the small series available for some forms. Nevertheless, it seems evident that comparisons can be useful within these limits.

As may be seen from Table 2, most kangaroo rat bacula have a rather oval base. In contrast to this, the roundness of the base in *ornatus* is apparently similar only to that of *D. ingens*, and is particularly unlike that of *D. spectabilis*. In general robustness (size of the base with respect to the length) *ornatus* is most similar to *D. ordi* and to members of the *heermanni* group (*heermanni, panamintinus, agilis*, etc.), and is unlike *merriami, nitratoides, spectabilis, deserti* and *microps*. The relative length of the baculum in *ornatus* (in terms of body length) is greater than in any species save *nitratoides*. It approaches *merriami* and *ordi*, however, fairly closely. On the other hand, it is relatively very much longer than that of *spectabilis, deserti* or *microps*.

Important differences are therefore found between the baculum of *D. ornatus* and that of all other species studied. It should be pointed out that, although the baculum of *D. phillipsi* is still unknown, *ornatus* and *phillipsi*

TABLE 2.—*Bacular proportions in several species of Dipodomys (species are arranged in order of increasing robustness; figures for species other than ornatus were calculated from the data of Burt, 1936)*

Species	No. of specimens	Roundness of base (dorso-ventral/ lateral diam. of baculum base)	Index of robustness*	Relative length (body length/ baculum length)
nitratoides	7	1.23	15.3	7.62
spectabilis	1	1.60	18.8	12.85
microps	2	1.27	19.9	12.50
merriami	14	1.27	20.6	9.58
deserti	1	1.30	22.4	15.47
ornatus	5	1.13	28.4	9.20
panamintinus	4	1.27	28.5	11.41
ordi	2	1.30	30.4	9.68
heermanni	5	1.40	30.8	11.07
agilis	3	1.20	31.2	—
ingens	2	1.12	31.3	11.57

* (Dorso-ventral diam. of baculum base + lateral diam. of baculum base) × 100/length of baculum.

are undoubtedly closely related and from a natural species group (the *phillipsi* group). Among the species whose bacula have been studied, *ornatus* is perhaps most similar in bacular morphology to the *heermanni* group, but differs mainly in possessing a baculum which is relatively much longer. Furthermore, its baculum differs markedly from that of *spectabilis, deserti* and *microps,* and approaches that of *merriami* only in relative length. Thus this evidence tends to suggest that the *phillipsi* group does not show obvious affinities to any particular studied species or group of species. It is more similar, however, to the *heermanni* group than it is to the *spectabilis* or *merriami* groups with which it is more usually associated. Since species of the *heermanni* and *ordi* groups are usually thought to be the most generalized of the genus, the type of baculum which they possess may also be generalized or more primitive in its features. The resemblance between the bacula of these three species groups may then be simply a matter of all being unspecialized in bacular morphology, and their phylogenetic relationship might still be remote.

The lack of similarity between the bacula of *ornatus* (and therefore presumably of *phillipsi*) and the *spectabilis* or *merriami* groups raises the question of the relationship of the relict species *D. elator.* Most workers have suggested that *elator* is either closely related to the *phillipsi* group (Grinnell, 1922; Setzer, 1949) or to the *spectabilis* group (Davis, 1942; Lidicker, 1960). Blair (1954) examined a single baculum of *D. elator,* and although he did not present any illustrations or measurements he indicated that it was most similar to that of *merriami* and unlike that of *spectabilis.* This bit of evidence suggests that *elator* is not especially closely allied to either the *phillipsi* or the *spectabilis* groups, and thus reopens the baffling question of its superspecific affinities. More information is certainly needed concerning the

baculum of this species, as well as of *D. phillipsi*, before a meaningful re-evaluation of its status can be made.

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SOUTHERN DISTRIBUTION OF THE ATLANTIC WALRUS

BY RICHARD H. MANVILLE AND PAUL G. FAVOUR, JR.

Over half a century ago it was suggested by Lucas (1891: 618–620) that the American walruses were threatened with extinction, the Pacific form being in greater danger than the Atlantic race. The populations of both have deen decimated, and the range of the Atlantic walrus in particular has diminished. Both still persist, however, and with the growing awareness of their need for protection, it may be hoped that their future is somewhat less precarious.

The Atlantic walrus, *Odobenus r. rosmarus*, now occurs in northern coastal waters, south to Hudson Bay, Hudson Strait, and Ungava Bay to western Greenland (Scheffer, 1958: 85–86). It is sporadic as far south as the upper Gulf of St. Lawrence (Lewis and Doutt, 1942). Fossil records of walruses in southern waters were compiled by J. A. Allen (1880: 57–65). Osborn (1910: 449) recorded a fossil from the coast of Georgia as indicating the southernmost extent of the species during the Pleistocene. Steirly (1956) gives an account of a fragmentary skull and tusk on Parramore Island, Virginia, uncovered in 1955 by the high water after Hurricane Connie. Speck and Dexter (1951) report walrus remains in a Micmac Indian refuse heap at Richibucto, New Brunswick, and Squires (1946: 35–36) records the species

from Shippegan Island and the mouth of the Shediac River as recently as 1761. Davies (1958: 103) considers that the Pleistocene population "must have been concentrated along the coast of N. America in the general vicinity of Long Island." New England records were listed by G. M. Allen (1930). In the past 30 years additional data have come to light, some presented here for the first time. Figure 1 indicates sites of former walrus occurrence in American waters south of Labrador.

Among the earliest observations of living North American walruses were those of Jacques Cartier on his first voyage in 1534. Some of his accounts and those of other early writers are cited by J. A. Allen (1880: 66–69). For instance, with reference to Ramea (probably one of the Sable Islands), Allen quotes: "About the said Island are very greate beastes, as great as oxen, which have two great teeth in their mouths like unto Elephants teeth, & live also in the Sea." He quotes further, concerning Ramea: "On which Isle are so great abundance of the huge and mightie Sea Oxen with great teeth in moneths of April, May and June, that there have bene fifteene hundreth killed there by one small barke, in the year 1591." Other accounts are given of the walrus as "a native of the Magdalen Islands, St. John's, and Anticosti in the Gulph of St. Lawrence." The slaughter of as many as "fifteen or sixteen hundred at one cut" on the Magdalen Islands is described. Thirty or forty animals on islands off Cape Breton were reported as follows: "Upon the lesse of these Islands of Birds we saw greate store of Morsses or Sea Oxen, which were a sleepe upon the rockes: but when we approached nere unto them with our boate they cast themselves into the sea and pursued us with such furie as that we were glad to flee from them." On Miscou Island, at the mouth of the Baie de Chaleur, walruses once occurred in large numbers; but by the concerted efforts of "The Royal Company of Miscou," as early as 1635, they were hunted to extinction.

Walruses were sought at an early date for the European market. Prior to 1582 it was recorded that "The teeth of the sayd fishes, whereof I have seen a dry flat full at once, are a foote and sometimes more in length; and have been sold in England to the combe and knife makers at 8 groats and 3 shillings the pound weight whereas the best Ivory is solde for halfe the money" (Jones, 1850). This extensive hunting during the 16th and 17th centuries, by the French and English in search of oil and ivory, drastically reduced the population in the southern parts of its range. Walruses probably hauled out or bred on some of the islets and shoals off the Gulf of St. Lawrence until the middle of the 18th century. Meanwhile, further north, they still continue to furnish the Eskimos with food, oil, leather, skins for kayaks, and ivory for implements, weapons and ornaments. The wasteful hunting methods employed, particularly when large groups are encountered, are described by Dunbar (1956). Much interesting information on the walrus near Southampton Island is presented by Carrick (1960).

In the past decade or so bony fragments of walrus have been reported

from several southerly points. Palmer (1944) reported remains from two New England localities: Assorted bones in potter's clay from Orrington, southern Penobscot County, Maine; and a skull with the left tusk dredged up in 1941 at Georges Bank, in the Gulf of Maine. Headstrom (1928) also recorded part of a skull, with tusks 12 and 14 inches long, recovered at Georges Bank, where it had probably been for upwards of 300 years. Dow (1954) reported a cranium and two tusks of a young adult dredged up from 230 feet of water in Bluehill Bay, Maine. Wright (1951) told of a large male

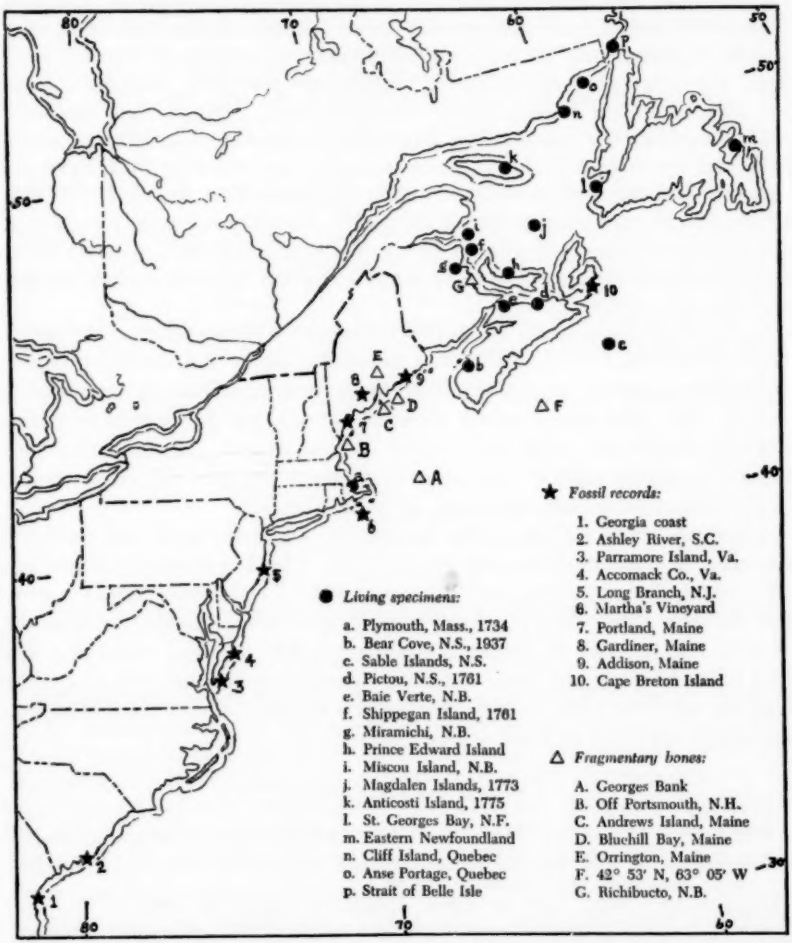

FIG. 1.—Records of the former occurrence of Atlantic walruses along the eastern American coast. Dates indicate latest published records of living specimens.

walrus killed by two fishermen in the Bay of Fundy near Bear Cove, Digby County, Nova Scotia, on 24 April 1937—the most recent record this far south. Loughrey (1959: 23) feels that these extreme southern records are of little significance and merely represent individuals "that drifted on the ice down the Labrador coast" and occasionally on through the Strait of Belle Isle.

Another Pleistocene specimen from Bluehill Bay was dredged up by a fisherman in 1956 from a depth of about 150 feet, at 44° 15′ N, 68° 26′ W. It is the property of Edwin Lawson, Sr. of Tremont, Maine; but through the efforts of Prof. Edward Sampson, of the Geology Department, Princeton University, it has come into the temporary custody of the Park Naturalist, Acadia National Park. This is a partial cranium, apparently of a young adult male (zygomatic breadth 228 mm.), lacking the left tusk. The cheek teeth are all present but heavily worn. The right tusk, badly eroded, measures 160 mm. along the anterior face from tip to alveolus. The left zygomatic arch and the left parietal and auditory regions are missing. Prof. Sampson suggests that this walrus suffered during life from sinus maladies. At least some of its injuries were sustained during life, for there has been a surprising amount of healing to the bones. The socket of the left tusk is nearly filled with cancellous bone; the bones of the left zygoma are well healed, but the arch has not regrown.

In the Marine Aquarium at Boothbay Harbor we have examined the specimen reported by Dow (1954). Both zygomatic arches and the left occipital and auditory regions are missing. Both tusks are present, though considerably eroded. The right tusk measures about 230 mm. along the anterior face; the left tusk, broken off at the tip, is about 53 mm. shorter. All cheek teeth are present except the right P^3, but are worn nearly to the gum line. None of the broken bones shows any indication of partial healing.

The range of the Atlantic walrus has receded far to the north, and in recent centuries its population has certainly declined. This has resulted partly from climatological changes since the Pleistocene and, more recently, from persecution by man. Stragglers to southern areas have been recorded as recently as 1937 (in the Bay of Fundy). We suggest that, in some cases at least, such individuals may be social outcasts—injured or otherwise unfit to remain with the northern herds—which, through the vagaries of winds and currents, are driven far south of their normal range.

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THE QUESTION OF THE PRONGHORN IN PIONEER MISSOURI

BY DANIEL MCKINLEY

Although Miller and Kellogg (1955: 816) include "northwestern" Missouri in the historical range of the pronghorn, *Antilocapra americana*, I have been unable to substantiate the claim. Similarly, I find little evidence to support Bennitt and Nagel's statement (1937: 3) that pronghorns, "according to the county histories, were found by the first settlers as far east as the present Lawrence, Johnson and Nodaway counties. They were soon driven farther west as their native prairie was broken up, and by 1840 they had disappeared from Missouri." Allusions to pronghorns in the county histories (not specifically cited by Bennitt and Nagel) were in the following anonymous accounts: 1888: 233; 1917: 398; 1881: 486, 554; 1910: 233. The pronghorn was also mentioned in the Pettis County history (Anon., 1882: 1078). Except

for Nodaway, these counties are in western Missouri, south of the Missouri river.

These county history references are uncertain as to time and place, and are not sufficiently elaborated in personal narratives to be accepted with assurance. Only the Nodaway County reference even purports to be a personal record. There the story is that, when white men settled the county (i.e., during the 1830's), "Indians still roamed over the rolling prairies. . . . Deer, antelope and even elk were plentiful" (Anon., 1910: 233). This statement is weakened by the phrase "even elk," for it implies that elk were less common than antelope, a most improbable situation.

As for on-the-spot observations, early travelers offer no evidence that pronghorns were found in Missouri. This statement is based upon the author's search of literature for his chronology and bibliography of Missouri wildlife (1960).

Josiah Gregg, in his compendium of prairie lore (1954: 37), gave Morris County, Kansas, as the pronghorn's easternmost limits. Zebulon Pike killed one in Lyon County, Kansas, in 1806 (Pike, 1932: 70). Few travelers' journals, however, reveal records of the pronghorn as close to Missouri as do those of Gregg and Pike.

There is remarkably little information on the pronghorn in Iowa (Scott, 1937: 45). That state would be a natural route for pronghorns to follow in reaching northwestern Missouri without swimming the Missouri river.

Although Alphonso Wetmore, a pioneer in Missouri and an early traveler on the Santa Fe Trail, did mention pronghorns in Missouri, his statement (1837: 26) that ". . . flocks of antelope graze in our prairies" is certainly indefinite. Schwarz (1920: 39) offers no evidence for claiming that the pronghorn was formerly found in "northern Missouri."

It is probable that modern references to the pronghorn in the state stem from Nelson (1925: map, page 2), who showed the antelope to have once occurred in extreme northwestern Missouri. No reasons were given in the text to substantiate the range shown on the map, and the range did not include the counties south of the Missouri river. Grinnell (1929: 135) explained that the species formerly occurred "possibly even in extreme western Missouri, though the statements are general and there is some uncertainty as to the western boundaries of Missouri at the time the record was made." Grinnell's statement was based upon unpublished data from the U.S. Biological Survey. Stanley P. Young (letter, 1957) states that information for the Missouri part of Nelson's distribution map "probably came from two of our [U.S. Biological Survey] men then stationed in that State, namely, Messrs. Mullins and Pope. . . ." This explains Nelson's map, but I remain puzzled by Grinnell's implication that his own information was from historically early days, not from the decade of the 1920's.

My belief is that pronghorns were never found within historical times in what is now the State of Missouri.

For help and advice in preparing this paper, I wish to thank William H. Elder and T. S. Baskett, under whom I studied at the Missouri Cooperative Wildlife Research Unit, University of Missouri.

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Biology Dept., Salem College, Winston-Salem, North Carolina. Received 28 September 1959.

PERSONAL NOTICES

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(continued on p. 536)

GENERAL NOTES

AN ALBINO *CRYPTOTIS* FROM MISSOURI

Plate I is a photograph of a pure white *Cryptotis parva* brought to me alive by Ray Williams, who captured it at Lathrop, Clinton County, Missouri, on 24 January 1953. The slightly matted appearance of the pelage was due to the food and moisture accumulated in the confining container; this condition persisted although we kept the animal alive in the laboratory for several weeks. Putrefaction following the animal's unexpected death prevented sex determination. The specimen is numbered 1971 in the University of Missouri collection.

The scarcity of pelage mutations and deletions in shrews has been remarked upon by numerous investigators. The occurrence of pure white shrews is even more rare—reports of only eight specimens could be found, and in only four of these was eye color reported as pink (Table 1). If all the pure white shrews tabulated were truly albinos, this condition has now been found in all three genera—the present specimen being the first for *Cryptotis*.

Other color aberrations seem little more common. The three specimens listed as blond are apparently similar to the condition known as *yellow* or *pink-eyed dilution* in mice. *Silvering* has been found in all three genera, and white-spotting in *Blarina* and *Sorex*. The white *Sorex cinereus* with dark muzzle and feet found by Findley (1955) seems similar to the *extreme dilute* factor (c^e) of the house mouse, otherwise known as black-eyed white. The pink-eyed white *Blarina* with scattered black (Shapiro, 1950) may have no parallel among mice. As yet there is no proof of the genetic identity of the phenotypes observed

TABLE 1.—*Coat color variations reported for North American shrews*

Species	Authority	Apparently albino	Others
Blarina brevicauda	Hatt, 1930		1 silvered
	Hamilton, 1939	one*	several white spotted
			1 blond
		one?	
	Murray, 1939	one	
	Sime, 1940	one*	
		one?	
	Christian, 1947		3 white spotted
			1 blond
			1 silvered
	Shapiro, 1950	one†	
Sorex cinereus	Pearce, 1934		1 white spotted‡
	Allen, 1935	one*	
	Findley, 1955		1 white with dark extremities
Sorex obscurus	Jackson, 1928		1 blond
			1 white spotted
Sorex tundrensis?	Jackson, 1928	one	
Cryptotis parva	Quay, 1943		3 pepper and salt
	Elder, this paper	one*	

* True albinos, eye color reported as pink.
† Pink-eyed but with scattered black hairs.
‡ Same specimen illustrated by Townsend, 1935, p. 79.

PLATE I

Albino *Cryptotis parva*. (*Photo by C. W. Schwartz.*)

in shrews with those known for mice, but the apparent similarities are suggestive of homology.—William H. Elder.

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SUCCESSFUL BREEDING IN CAPTIVE *ARTIBEUS*

Successful breeding of microchiropterans in captivity seems only to have been reported by Trapido (Jour. Mamm., 27: 217–219, 1946) and Wimsatt (*in* Griffin, LISTENING IN THE DARK, Harvard Univ. Press, 1958, p. 21) for colonies of the vampire, *Desmodus*. Breeding has also been reported for captive megachiropterans of the genera *Pteropus* and *Rousettus* (Kulzer, Z. *Morph. u. Okol. Tiere*, 47: 374–402, 1958; G. M. Allen, BATS, Harvard Univ. Press, 1939, pp. 49, 242).

During July and August 1958, I collected some 15 individuals of *Artibeus jamaicensis* from three Mexican sites, for physiological experiments dealing with acoustic orientation. These include four females from the hacienda of Atliuayan, Yautepec, Morelos; four pregnant females from Salitre Cave, Morelos; and seven mature males and females from a building at Boca del Rio, Vera Cruz. The pregnant females all aborted nonviable fetuses within a few hours of captivity. These bats were captured with the help of Bernardo Villa-R. and were identified in life by him. I am grateful for his unsparing help, advice and hospitality during my stay in Mexico. I am also grateful to Allen Grinnell for help in capturing and caring for these bats and to Robert A. Grummon for his devoted care of the bats during much of the ensuing year. The field trip to study orientation in neotropical bats was sponsored by the Lalor Foundation of Wilmington, Delaware, under a summer research fellowship.

About 12 *Artibeus* of uncounted sex distribution, along with a number of other Mexican bats, were brought to New Haven in September 1958 in the hope of establishing laboratory colonies. A single *Macrotus mexicanus* aborted a well-developed fetus in January 1959, presumably conceived in captivity.

Of the *Artibeus*, about nine survived the initial adjustment period and three more died during the following winter. Six individuals still survive in apparently perfect health in September 1959, after 13 months of captivity. During this time, the bats were kept in a room in which they were free to fly except for brief, scattered periods when they were enclosed for convenience in a cage. Room temperature was regulated at about 80°F. The bats were exposed to light only irregularly, during the day, when they were fed or when their room was being used for experimental purposes. Otherwise they lived in constant darkness. Their regular diet consisted of ripe bananas and fresh or frozen cantaloupe and honeydew melon. On rare occasions their diet was supplemented with other types of melon, mangoes or papaya. They usually refused all other fruit and fruit juices available in New Haven. Small amounts of lemon-flavored Vi-Daylin vitamin preparation were added to their drinking water but they rarely consumed any significant amount of water.

In March 1959, one female aborted a well-developed fetus. In April 1959, another female delivered a well-formed single young which died, however, within 24 hours. On 27 July 1959, a female which had last been observed pregnant on 16 July was found carrying a single young. Its birth date cannot be fixed more exactly. This young bat has continued to do well, was first observed to be separated from its mother on 21 August, first flew in my presence on 23 August, and was last seen nursing on 28 August. Since that time (as of 21 September) it has, nevertheless, usually been found hanging with or on its mother and usually near the other females. By 5 September, it was flying well.

On 25 August 1959, a second female delivered a healthy, single male which has continued to do well and has been seen separate from its mother only once on 10 September. It has not yet flown as of 21 September. On 10 September 1959, a third female delivered a healthy baby. It was found at 11:00 AM with the apparently newly delivered placenta still attached. At noon, the placenta had disappeared, presumably having been eaten. The infant has been in apparent good health and, as of 21 September, has never been seen other than attached to its mother's nipple.

I have refrained from measuring or studying these first successful captive-born *Artibeus*

for fear that they would be rejected by their mothers, who have never become accustomed to human interference. All three of these young were conceived in captivity; they were born 11, 12 and 13 months after their mothers' capture. Presumably the two earlier, unsuccessful pregnancies also developed in captivity. *Artibeus* are apparently capable of more than one pregnancy per year. There is no clue as to the stimulus for ovulation in these bats; the males have been observed with scrotal testes from time to time, but no record has been kept of the dates. It appears that with warmth, seclusion, adequate diet and freedom from handling, *Artibeus jamaicensis* will breed with success in captivity. They promise to become a valuable laboratory species.

The baby hangs, head down, on one of the pecto-axillary nipples as long as it is attached to the mother. For the first 10 days, the baby holds onto its mother with its hind feet, as well, its legs apparently around its mother's thigh. Later, it usually hangs by one foot from the same roost as the mother. The other leg is around the mother's thigh. Except for the one hind foot, the baby, at least until the time it starts to fly, is always concealed from view by its mother's wing. The pregnant females segregated themselves from the other members of the colony about one week before parturition and joined a nursery group consisting of the other females in an advanced state of pregnancy, the lactating females, and the recent young. This nursery group could usually be found clustered together in an intimate manner in the same secluded spot. The other females and the males roosted together in looser aggregation in other parts of the room.—Alvin Novick, *Dept. of Zoology, Yale University, New Haven 11, Connecticut.* *Received 23 September 1959.*

A POSSIBLE BAT MIGRATION

Early on the morning of 17 October 1959, I was awakened by my dog who wished to go out, so I hastily donned a robe and took her downstairs. After the mission was accomplished I started up the staircase toward the landing, where there is a large plate-glass window, facing west. I was suddenly struck by the brilliance of the full moon, which was in the descendency, and directly before me in the western sky. I paused on the landing to look at the sky, and while I was standing there I noticed what I assumed to be a flock of birds coming from the west and heading directly east. The appearance of the flock puzzled me somewhat, for it resembled, in outline, a swarm of bees rather than a flock of birds in migration. As the flight approached and I was able to see the individuals distinctly, I was amazed to discover that they were bats, rather than birds! They were tightly massed and wings seemed to overlap wings. One got the illustion of a fluttering shape moving through the air. There were no solitary individuals.

It seemed evident to me that these bats were not on a feeding flight but, rather, heading for a definite destination. They flew over our garage roof, gaining sufficient altitude to clear our house roof, but with little room to spare. I started to count them, but only reached 75 when I realized the futility of such an attempt. In my opinion, there were at least 200 individuals in the flight.

It was not possible for me to determine the identity of the bats, but they did not appear to be the sharp-winged type, such as *Lasiurus*. Because of their size I am inclined to think that they were *Eptesicus*, but am reluctant to state this definitely.

When the flight passed out of my vision I noted that it was just about 4:00 AM, Eastern Standard Time. The weather was clear, the sky cloudless and the temperature probably in the upper 40's, since the minimum for that day was 48°, the maximum 65°, and the average 57°F.

Our house is in the East End district of Pittsburgh, Pennsylvania, on top of a hill, at an elevation of 1,100 feet.—Caroline A. Heppenstall, *Carnegie Museum, Pittsburgh 13, Pennsylvania.* *Received 15 January 1960.*

UNDERWOOD'S MASTIFF BAT IN ARIZONA

A single specimen of Underwood's mastiff bat, *Eumops underwoodi sonoriensis* Benson, has been reported from the United States (Baker, Jour. Mamm., 37: 111–112, 1956). This specimen was shot over a pond 2 miles east of Sasabe, Pima County, Arizona, on 5 May 1954, by William J. Schaldach, Jr. On 16 July 1958, Schaldach took one of us (ALG) to the site where he had collected this specimen. The locality is an earth dam tank, locally known as Garcia's Represso. It is almost exactly 2 miles east of Sasabe and only a few hundred yards north of the International Border. The tank is a catch basin for runoff rain water and is used to supply water for livestock in the area. The water level and surface area of the water varies considerably during the year but the pond is completely dry only in exceptionally dry years. It is in a mesquite bosque situation, at an elevation of approximately 4,000 feet. It is approximately 6 miles from the nearest low mountains to the east, and some 12 miles from the nearest low mountains to the west.

On 16 July the water level was low, only 18 inches deep in the deepest parts, and covered an area approximately 100 feet long by 35 feet wide. Three "mist" nets were set across the pond. The night was very dark, slightly cloudy, and with a faint breeze that blew most of the night. The first *Eumops underwoodi* was caught at 8:45 PM; by midnight a total of seven had been taken; between midnight and 3:30 AM one additional individual was taken; and between 3:30 and 5.00 AM three additional *Eumops* were caught. A total of 11 (8 females and 3 males) were taken during the night and all were saved as specimens. The following bats were also taken in the nets during the night: 6 *Myotis velifer*, 13 *Eptesicus fuscus*, 7 *Antrozous pallidus*, 9 *Tadarida brasiliensis*, and 3 *Tadarida femorosacca*. Most of these were banded and released.

The presence of mastiff bats in an area may be detected by listening for their characteristic high-pitched "peeps," emitted several times a minute as they fly. In *Eumops underwoodi* these peeps are much more intense than are those of the greater mastiff bat, *Eumops perotis*, and are, in fact, so intense that when one approaches close to an observer, the sound actually hurts his ears.

One of the female *Eumops underwoodi* contained a single embryo that was 39 mm. in crown–rump length. The other seven females were lactating but did not have their young with them.

A second visit was made to this locality on 25 July 1958. At this time the water level was even lower, 9 to 10 inches at the deepest place, and covered an area approximately 20 feet wide and 50 feet long. A single "mist" net was set over the pond at this time. The night was cloudy and a fine misty rain fell during most of the night. Seven additional *Eumops* were taken (5 males and 2 females). The five males were saved as specimens, the females were banded and released. In addition, the following bats were taken: 5 *Myotis velifer*, 1 *Eptesicus fescus*, 1 *Pipistrellus hesperus*, 4 *Antrozous pallidus*, 2 *Tadarida brasiliensis*, and 4 *Tadarida femorosacca*.

Average, minimum and maximum measurements (in millimeters) of 7 males and 8 females are: Total length, 163.3 (160–167), 167.0 (162–170); tail, 55.8 (52–60), 59.13 (57–64); hind foot, 17.0 (15–20), 18.3 (15–20); ear, 31.3 (29–33), 29.6 (27–30); forearm, 69.0 (67.5–70.4), 69.0 (67.6–70.5); greatest length of skull, 29.3 (28.6–30.0), 28.8 (28.4–29.1); condylobasal length, 26.8 (26.5–27.1), 26.6 (26.0–26.7); zygomatic breadth, 17.7 (17.5–18.1), 17.4 (17.3–17.5); least interorbital width, 5.5 (5.4–5.6), 5.45 (5.4–5.5); width at m^3, 12.3 (12.0–12.6), 12.1 (11.8–12.4); maxillary toothrow, 11.5 (11.4–11.7), 11.5 (11.3–11.75); length of mandible, 20.8 (20.3–21.2), 20.5 (20.1–20.8).

Comparisons of these measurements with those published by Benson (Proc. Biol. Soc. Wash., 60: 133–134, 1947) for the only other known series of specimens of this species (11 specimens, 10 males and one female, seven of which were taken at Rancho de Costa Rica, Rio Sonora, and four from 10 miles NW Noche Buena, approximately 18 miles NNW Guaymas, Sonora, Mexico) reveals that few differences are evident. Weight in grams, however, is a striking exception. The average and extreme weights of the

11 bats taken in Sonora were 47.9 (40.0–55.6) grams while the weights of those taken in Arizona were: males, 56.8 (53.0–60.5); females, 57.3 (54.1–65.3). Perhaps these are seasonal differences (all bats in both series were adults) since the Sonoran series was taken in the month of May and those from Arizona were taken in July.

The field work on which this study was based was supported by a National Science Foundation Research Grant G5209, Biology of the Bats of the Southwest.—E. Lendell Cockrum and Alfred L. Gardner, *Dept. of Zoology, Univ. of Arizona, Tucson. Received 14 September 1959.*

SOUTHERN YELLOW BAT FROM DURANGO, MÉXICO

A male southern yellow bat, *Dasypterus ega xanthinus* Thomas, from "Aguajequiroz," 12 miles south-southwest of Mapimí, 5000 feet elevation, Durango, was captured on 27 June 1958. This bat was snared on a rainy evening, after dark but before 9:00 PM, in a mist net stretched across a shallow pool of muddy water located in a narrow canyon in a low, arid, mountainous area. *Yucca, Agave, Larrea, Acacia* and *Opuntia* were prominent plants found on the sides of the canyon. Heretofore, the only records of the southern yellow bat in close proximity to the state of Durango, to my knowledge, are listed by Hall and Kelson (Mammals of North America, Ronald Press, New York, 1959: 194) from Coahuila (4 miles south Hacienda La Mariposa), Zacatecas (Concepción del Oro), and Sinaloa (1 mile south of Pericos). The present record extends the known range of this species to northeastern Durango; this bat probably also occurs uncommonly in other parts of north-central México. Financial assistance for field work is acknowledged from the MSU Development Fund.

Measurements (in mm.) for this Durangan specimen (MSU No. 3287) are: total length, 109; length of tail vertebrae, 49; length of hind foot, 10; height of ear from notch, 14; length of forearm, 43.7; condylobasal length of skull, 14.8; zygomatic breadth, 11.0; breadth of braincase, 8.6; least interorbital constriction, 4.8; mastoidal breadth, 8.9; length of maxillary toothrow, 5.5; breadth across upper canines, 5.7; breadth across upper molars, 7.3; weigth, 13.7 grams.—J. Keever Greer, *The Museum, Michigan State Univ., East Lansing. Received 28 September 1959.*

GEOFFROY'S TAILLESS BAT IN DURANGO

A male, tailless bat identified as *Anoura geoffroyi lasiopyga* (Peters) was captured on 20 July 1957, in a mist net stretched across the Río Piaxtlá, 1½ miles west of San Luis, Durango, at an elevation of approximately 7550 feet. The bottom and lower slopes of the moist, cool canyon containing this river supported a stand of boreal vegetation including pine, Douglas fir, and juniper with an understory of mosses, ferns and forbs growing among massive rocks (see Hooper, Occ. Pap. Mus. Zool., Univ. Mich., No. 558: 3–4, 1954). It is suspected that the presence of this species in the boreal habitat is unusual, and the bat normally may occur downstream several miles where the stream is bordered by subtropical vegetation characteristic of the Pacific slope of Sinaloa.

The taking of this specimen in Durango extends the known range of the species approximately 185 miles northward. The most northern locality for this species previously was 2 miles southeast of Jalcocotán in Nayarit (Anderson, Univ. Kansas Publ., Mus. Nat. Hist., 9 (9): 350, 1956). The Durangan specimen (MSU 905) weighed 13.8 grams and has the following measurements (in mm.): Total length of head and body, 65; length of hind foot, 13; height of ear from notch, 13; length of forearm, 44.0; greatest length of skull, 24.7; condylobasal length, 24.1; least interorbital constriction, 4.8; palatal length, 13.6; mastoidal breadth, 10.2; width of brain case, 9.8; depth of braincase, 7.4. The first three dimensions are well within the range of those for specimens of this subspecies from Chiapas listed by Anderson (Chicago Acad. Sci., Nat. Hist. Misc., No. 159: 2, 1957).

Acknowledgement is made to the Michigan State University Development Fund for financial assistance in connection with field work.—ROLLIN H. BAKER, *The Museum, Michigan State Univ., East Lansing. Received 7 August 1959.*

MYOTIS SODALIS EVIDENTLY BREEDING IN INDIANA

On the evening of 18 June 1959, Calvert shot a female *Myotis sodalis* containing a large fetus (39 mm. total length). This animal was collected 2½ miles west and ¾ of a mile north of Mongo, Lagrange County, Indiana, along with specimens of *Lasiurus borealis*. The late date and the developmental stage of the embryo suggest that the bat was on its breeding grounds. The specimen (REM 1839), preserved as an alcoholic, is evidently the first breeding *sodalis* to be reported.

The collecting site was the border of a small, open woodlot, composed of hardwoods and surrounded by cultivated land. Periodic shooting at the site during the following two weeks produced only *L. borealis*, *L. cinereus* and *Eptesicus fuscus*. Lagrange County lies within the Northern Moraine and Lake Region (Malott, HANDBOOK OF INDIANA GEOLOGY, 1120 pp., 1922) of Indiana. This region is characterized by numerous, broad, lacustrine plains, lakes, wide marshes (or drained marshes), low sand ridges or knolls, and massive, sometimes rugged, terminal moraines. Timbered tracts are small and occur largely as woodlots or narrow bands of riparian growth; a few tamarack bogs are present.—RUSSELL E. MUMFORD AND LARRY L. CALVERT, *Dept. of Forestry & Conservation, Purdue Univ., Lafayette, and Indiana Dept. of Conservation, Howe, Indiana. Received 27 August 1959.*

A LONGEVITY RECORD FOR THE MINDANAO TARSIER

On 20 June 1959 a female Mindanao tarsier, *Tarsius syrichta carbonarius*, died at the Philadelphia Zoological Garden after having resided in the Small Mammal House there since 28 July 1947. This rare little primate was one of a pair obtained from Charles H. Wharton, who successfully transported some 30 living tarsiers from the Philippines to the United States in July 1947. The Philadelphia specimens were collected in April 1947 near Caburan, Mindanao, so the above-mentioned female was at least 12 years old. The male lived 3 years 1 month 21 days at the Philadelphia Zoo. In his excellent monograph of Primates (Vol. 2: 125), W. C. Osman Hill states that the tarsiers received by the Zoological Society of London from Wharton outlived "all their transatlantic contemporaries." Since they survived for periods varying from 2 years to 2 years 10 months, it is obvious that Osman Hill overlooked the Philadelphia specimens completely.

The teeth of the 12-year-old female show little sign of wear, although the animal chewed its food extremely well. The tarsiers were fed white mice, green anoles, and various orthopterans, but the mainstay of their diet was *Anolis carolinensis*. Autopsy of the female at the Penrose Research Laboratory of the Philadelphia Zoological Garden revealed slight degenerative changes in the heart and kidneys and microscopic signs of arterio-sclerosis, but it could not be termed an old animal. The ovaries were not atrophic and, although there was a low level of endocrine activity, this may well have been due to a long life of isolation in captivity.

Despite its small size the tarsier, as a primate, is a member of a long-lived order and I venture to predict that it will be found to have a potential longevity of at least 20 years—comparable to many lemurs and monkeys. A more detailed paper on the Philadelphia Zoo tarsiers, which produced the first young (2) ever bred in captivity, is in preparation by the writer.—FREDERICK A. ULMER, JR., *Zoological Society of Philadelphia, Philadelphia, Pennsylvania. Received 20 August 1959.*

JACK RABBITS GALORE

Even though we all realize the great numbers of wildlife encountered by the early explorers, we also realize that hunters like to exaggerate, and we are naturally suspicious of the "millions" and "thousands" reported. So when photographic evidence is occasionally available, it is very welcome.

In my possession are several photographs, unpublished so far as I know, depicting astonishing numbers of one of the lesser denizens of the plains. These photographs were

PLATE I

Jack rabbit drives in earlier days. ABOVE: Thousands of rabbits in a pen after drive; Oregon, date unknown. BELOW: Results of Grand Army drive at Fresno, California; prior to 1896. (*U.S. Biological Survey photos.*)

furnished me many years ago by the Bureau of Biological Survey, with permission to reproduce them. Two of these (Plate I) illustrate jack rabbit drives, with no evidence of the precise dates save that furnished by the costumes of the men. The procedure in such cases was for as many mounted men as could be assembled to form a ring and drive the hares into a pen; the entrance was then closed and the animals clubbed to death. Certainly no such sight will be seen again. One is astounded at the numbers involved and can readily imagine with what delight the ranchers welcomed the elimination of this competitor on their cattle ranges. It is safe to assert, however, that not one of them gave a thought to the question of what prey the normal predators of these jack rabbits would thenceforth be forced to seek.

PLATE II

Pile of 1,641 prairie dogs poisoned in one night on 320 acres of the Coconino National Forest, Arizona; 7 September 1917. Total cost of extermination, including labor, $9.79. (*U.S. Biological Survey photo.*)

The third photograph (Plate II) is not so amazing as to numbers, at least to one who has seen the density of prairie dogs for mile after mile in parts of the West during the early part of this century. Still it is of interest in illustrating a sight that will never occur again.—A. Brazier Howell, *Alna, Maine. Received 4 April 1960.*

A MELANISTIC CHIPMUNK

On 20 October 1958 a coal-black eastern chipmunk, *Tamias striatus,* was brought to me by Anthony Taormina of the New York State Bureau of Game. The chipmunk had been killed in Middleville, Herkimer County, New York.

Upon close examination a few short white hairs were found on the back and cheeks. Aside from these few hairs the animal is totally black. It is a male with measurements

as follows: length 9⅝, tail 4, foot 1.4, ear (notch) ½ in.; weight 134.5 grams. The weight is probably less than normal since the animal had been dead about one day.

This is the first record I know of for a melanistic chipmunk. Black squirrels, *Sciurus carolinensis*, and black woodchucks, *Marmota monax*, are quite common in this area.

The study skin and skull are in the mammal collection of the State University College of Forestry at Syracuse, New York, under Accession No. 10,114.—LeRoy C. Stegeman, *State Univ. of New York, Coll. of Forestry at Syracuse Univ. Received 24 September 1959.*

INDIAN PALM SQUIRREL "PLAYING POSSUM"

On 15 June 1959, while returning from the small jungle in the vicinity of the College of Science, Raipur (M.P.), we happened to see a palm squirrel, *Funambulus pennanti*, climb a tree. One of us aimed at it with an airgun but the first two shots failed to hit the animal due to its active movements on the branches of the tree. Ultimately, it climbed to the topmost branch and took up such a position that only its tail could be seen. The third shot was aimed at the tail of the animal with the intention of disturbing it from its invulnerable position. To our surprise, the squirrel fell onto a lower branch in a manner suggesting that it had been hit. It hung upside down clinging to the base of the branch with only its hind feet. It appeared about to drop down dead. The head was hanging loosely with eyes half-closed and the grip of the hind feet appeared to become weaker every moment. None of us, then, had any doubt of its being fatally injured, though no trace of blood could be seen. One of us, getting somewhat impatient, climbed up the tree with the intention of bringing the animal down. However, when he stretched his hand to catch hold of the squirrel, to our utter surprise, it suddenly started moving and within a few seconds it climbed down the tree and ran away faster than any of us could follow, and disappeared.—D. R. Sharma, *Arts and Science College, Raigarh,* S. Sivaram, *College of Science, Raipur,* and K. Verma, *K. R. G. College, Gwalior, India. Received 14 September 1959.*

THE TYPE LOCALITY OF THE SOUTHERN GRASSHOPPER MOUSE

Most recent publications have listed the type locality of *Onychomys torridus torridus* (Coues) as "Camp Grant, Graham County, Arizona" (see Miller and Kellogg, U.S. Nat. Mus. Bull., 205: 517, 1955; Hoffmeister and Goodpaster, Illinois Biol. Monogr., 24: 111, 1954; Poole and Schantz, U.S. Nat. Mus., Bull. 178: 303, 1942). The information available on the type specimen (a skin only, No. 9886, in the U.S. National Museum) indicates only that it was taken at Camp Grant, Arizona, on 10 June 1867, by E. Palmer.

The history of the name and location of this military post is obscure. It was variously known by three (or perhaps four) names and occupied two (or perhaps three) different sites. The names and their histories follow:

Fort Arivaypa (sic), on the San Pedro River, at its junction with Aravaipa Creek, T.7 S, R.16 E, Pinal County, Arizona. According to Jerome Stone (Thesis MS, Univ. Arizona Library, "The History of Fort Grant," 1941), this fort was established on 8 May 1860 (although some sources indicate that it was established as early as 1856) and underwent a name change to Fort Breckenridge on 6 August 1860.

Fort Breckenridge. According to Richard J. Hinton (The Handbook of Arizona, 1878 [republished by photo-offset in 1954 by Arizona Silhouettes, Tucson, Arizona], p. 311), "Camp Grant was originally located at the confluence of the Nevaissa [= misprint for Aravaipa?] and the San Pedro rivers, in 1856, being then designated as Fort Breckenridge." On page 40, Hinton indicated that Fort Breckenridge was abandoned in July 1861 and burned in 1862. According to Francis B. Heitman (Historical Register and Dictionary of the United States Army, 1789–1903, Washington, D.C., vol. 2, p. 477, 1903), it was

"So named for the then Vice President of the United States." As far as I can determine, no Breckenridge was ever Vice President but John Cabell Breckinridge was Vice President from 1857 to 1861. According to Stone (*op. cit.*) the name "remained Fort Breckenridge until May 18, 1862, when . . . [it was changed] to Fort Stanford."

Fort Stanford. According to James H. McClintock (ARIZONA, S. J. Clarke Publ. Co., Chicago, Vol. 1, pp. 150, 159, 1916) Fort Breckenridge "was re-established . . . [by] Lieut. Col. E. E. Eyre in 1862. Then it was re-christened Camp Stanford, after the Governor of California, but later was named Camp Grant. . . . There was much malaria probably caused by drinking stagnant water from the river where there were many lagoons caused by a succession of beaver dams." Stone (*op. cit.*) stated that "Sometime between October, 1863, and July, 1865, the name was apparently changed back to Fort Breckenridge."

Fort Grant. Stone (*op. cit.*) stated that "On November 1, 1865, the name was changed to Camp Grant." However, according to Will C. Barnes, (ARIZONA PLACE NAMES, Univ. Arizona Bull., 6 (1): 188, 1935), "Gen. O. O. Howard says: 'It was renamed Fort Grant in 1866, for Gen. U. S. Grant. . . . Post office at first Camp Grant on San Pedro established Aug. 19, 1869, George Cox, P. M.'"

As pointed out by Barnes (*loc. cit.*), there appears to be some doubt as to the first location of Fort Grant. "Gen. Mason says: 'Fort Grant as a separate post was originally placed on the Gila at the mouth of the San Pedro. Floods washed it out in 1865 and it was moved up the river to the site of old Fort Breckenridge.' Report of Gen. John Mason, Apr. 29, 1866." Barnes further stated that Old Fort Grant "was abandoned in Oct., 1866, and a new post established Dec. 19, 1872, at the base of Graham Mountain, in sec. 24, T9S, R23E." Other sources indicate that the location on the San Pedro River was not abandoned until sometime in 1871.

The topographic map that includes the junction of Aravaipa Creek and the San Pedro River (Lookout Mtn., Arizona, Quadrangle, 7.5 minute series, edition of 1950) delineates the approximate boundary of "Old Camp Grant Military Reservation" as including parts of sections 3, 4, 5, 9, 10, 15, and 16, T.7 S, R.16 E.

In any case, it is obvious that the type specimen of *Onychomys torridus torridus* (Coues), taken on 10 July 1867, was not taken at the present location of Fort Grant, in Graham County, Arizona. In all probability it came from the junction of Aravaipa Creek and the San Pedro River in Pinal County, Arizona. Therefore, the statement of the type locality should read as follows: Old Camp Grant [jct. Aravaipa Creek and San Pedro River, 2160 feet, T.7 S, R.16 E, 8 miles north and 5 miles west of Mammoth, Pinal County], Arizona.—E. LENDELL COCKRUM. *Dept. of Zoology, Univ. of Arizona, Tucson.* *Received 14 September 1959.*

SIZE VARIATION IN THE RICE RAT

According to Goldman (N. Amer. Fauna 43: 7; 1918), the range of individual variation in the genus *Oryzomys*, especially in size, is extraordinary; in many species of corresponding age and sex it exceeds 10 per cent both in external and cranial measurements.

During an examination of *Oryzomys palustris palustris* in the collections at the U.S. National Museum, it was found that the size variation within adult populations was remarkable but, in this subspecies, small size is invariably associated with the female sex. It may not, however, necessarily represent sexual dimorphism, since many females are as large or larger than males.

An interesting example of this size difference is found in a series of 13 specimens collected in a marsh at Back Bay National Wildlife Refuge, 6.8 miles SE Pungo, Princess Anne County, Virginia, in April 1956. The series is easily divided into two clearly defined size groups, a large one of eight individuals of both sexes and a small-sized group of five females. Each appears to be composed of adults, and there are some

individuals in both groups that seem to be old animals, having well-worn teeth. Standard cranial measurements for the large group are as follows: Greatest length of skull, 30.3 (29.2–31.9); zygomatic breadth, 15.8 (15.3–16.9); length of molariform toothrow, 4.5 (4.4–4.6) mm. The small-sized group measures: Greatest length of skull, 27.4 (26.7–28.0); zygomatic breadth, 14.5 (14.3–14.8); length of molariform toothrow, 4.1 (4.0–4.3). It is evident that the largest of the first group exceeds the smallest of the second, in greatest length of skull, by 19.5 per cent, and the average of the first exceeds that of the second by 10.6 per cent. Although this is a very small sample, the variation in size is remarkable and represents an exaggeration of a characteristic found throughout this subspecies.

It may be that tooth wear, resulting from differential feeding habits, gives a false impression of age, and that small animals are actually immature. However, in this case they were taken in the same marsh at the same time of year, and presumably the same foods were available to them. The fact that, in all the *Oryzomys palustris palustris* examined at the National Museum, small size was invariably associated with females, also seems to make this explanation unlikely.

A possible explanation for this small size is that these females become pregnant at a very early age, before full size is reached, resulting in decalcification or other nutritional deficiency in the mother caused by the developing embryos. This might result in rapid wear of the teeth and a consequent false impression of age, or actually in stunted growth. This possibility, however, would call for further more intensive investigation.—JOHN L. PARADISO, *U.S. Fish and Wildlife Service, Washington 25, D.C.* *Received 12 September 1959.*

BANNER-TAILED KANGAROO RAT IN CENTRAL ARIZONA

In May 1958, two male banner-tailed kangaroo rats, *Dipodomys spectabilis perblandus*, were captured north of Scottsdale, Maricopa County, Arizona. One was from 5 miles north and ½ mile east, the other from 10 miles north and 2 miles east of Scottsdale. Since that time many other banner-tailed kangaroo rats have been seen at night in the same region and several additional specimens have been taken.

The nearest records of this species that I have been able to find in the literature are from Oracle (Goldman, Jour. Wash. Acad. Sci., 23: 463–473, 1933) and along U.S. Highway 80 between Florence and Tucson (Doutt, Ann. Carnegie Mus., 23: 241–274, 1934). The new records from north of Scottsdale extend the range of the species approximately 90 to 95 airline miles to the northwest.

The area north of Scottsdale consists of relatively flat, sandy to gravelly desert covered with creosote bush (*Larrea tridentata*) and *Atriplex* (*Atriplex polycarpa*). The characteristic and conspicuous mounds of the banner-tailed kangaroo rat are abundant. Associated mammalian species collected in the same area are: *Sylvilagus auduboni, Lepus californicus, Citellus harrisi, Thomomys umbrinus, Dipodomys merriami, Peromyscus maniculatus, Peromyscus eremicus, Urocyon cinereoargenteus* and *Lynx rufus*.—RONALD R. CLOTHIER, *Dept. of Zoology, Arizona State Univ., Tempe.* *Received 2 October 1959.*

THE CRICETID MOUSE, *CALOMYS*, FROM VENEZUELA

During the summer of 1958, Arnold Menke, Stephen Bromley and I made collections of animals in northeastern Venezuela for the Los Angeles County Museum. The facilities of the United Geophysical Corporation were made available to us, and part of our collecting was conducted from a temporary headquarters camp located 42 km. southeast of Maturin in the State of Monagas. Thirteen specimens of *Calomys laucha* were collected in the immediate area of the camp. The animals were identified by Charles A. McLaughlin of the Los Angeles County Museum and Philip Hershkovitz of the Chicago Museum of

Natural History, who compared them with specimens in the Chicago Museum. The specimens are now located in the Los Angeles County Museum, Los Angeles, California.

The genus *Calomys* (= *Hesperomys*; Hershkovitz, Jour. Mamm., 40: 339, 1959) has not been previously known from Venezuela. According to Osgood (Jour. Mamm., 28: 165–174, 1947) the genus ranges from southeastern Brazil and Uruguay to northern Argentina, through southern Paraguay to Bolivia, Peru and southeastern Equador. The present extension of the known range is possibly due to artificial introduction and establishment in the northern part of Venezuela. Units of the United Geophysical Company are also located in Bolivia, and equipment is frequently shipped back and forth between camps. It is possible that these mice were transported in equipment and subsequently became established in Venezuela.

These short-tailed mice were timid creatures and seldom tried to escape when uncovered. All were collected by hand and, although they bite if molested, only one of them made an attempt to bite and escape. Four animals were found hiding under trash or boards in the camp area. Six had taken up residence in hollow logs and were found as far as 1000 feet from the camp in an adjacent marshy meadow.

Of the thirteen specimens collected, nine were adults and four were juveniles. Five adult males had scrotal testes averaging 10 × 5 × 4 mm. All four adult females were pregnant. Three contained four embryos or fetuses ranging from 4 to 20 mm. (crown-rump); one female contained three fetuses measuring 12 mm.

A nest containing three recently born young was uncovered under a board in the camp area. The nest was a shallow depression in the ground, lined with fine grasses. The mother stood over the young which lay on their backs while nursing. The hairless young measured approximately 36 mm. (total length) and had tightly closed eyes and ears. The mother later deserted the nest and the young were preserved in formalin.

Average external measurements (in mm.) of adults are as follows (figures for females follow those for males; ranges are in parentheses): Total length, 113 (96–120), 108 (95–120); tail length, 45 (35–54), 39 (31–45); hind foot, 15 (15–16), 14 (11–16); and ear from notch, 12 (10–13), 12 (10–13).—Bernard B. Butterworth, *Univ. of Southern California, Los Angeles.* *Received 5 October 1959.*

ADDITIONAL RECORD OF *PEROMYSCUS MANICULATUS BAIRDI* IN NEW YORK

Peromyscus maniculatus bairdi has been taken in New York State only at Elba, Genesee County, and at Ithaca, Tompkins County (Hamilton, Jour. Mamm., 31: 100, 1950). We took four at North Pond, Oswego County, from 25–28 June 1959. This locality is approximately 110 miles east of Elba and about 80 miles northeast of Ithaca.

Two young were taken in Havahart traps, and two adults in snap traps. Of the two adults, one was a female (total length 140, tail 59, hind foot 17 mm., weight 21 gm.) taken on 26 June, containing four embryos which averaged 17 mm. crown to rump. The other was a male (total length 157, tail 62, hind foot 18 mm., weight 23.9 gm.) taken on 27 June.

North Pond is a bay located near the southeast corner of Lake Ontario and separated from the lake by a narrow barrier beach, some 200 yards wide. The mice were taken on the barrier beach in a moist depression between sand dunes in a stand of *Juncus effusus* and the young shoots of a grass. *Populus tremuloides*, several species of *Salix*, *Potentilla anserina* and *Artemisia caudata* were also common. Beach grass (*Ammophila breviligulata*) covered the dunes.

Other mammals taken in the 150 trap-nights were six *Zapus hudsonius* and three *Microtus pennsylvanicus*.—John O. Whitaker, Jr. and Robert E. Goodwin. *Dept. of Conservation, Cornell Univ., Ithaca, New York.* *Received 24 August 1959.*

CARNIVORES IN PUEBLA, MEXICO

There are relatively few reports on the mammals of the state of Puebla, Mexico, and the following records of carnivores there may be of interest. These notes were made from 23 December 1953 to 16 January 1954, during which time I was a guest at the home of Dyfrig McH. Forbes in the town of Izucar de Matamoros, Puebla. I am greatly indebted to Mr. Forbes and his family for their hospitality and assistance during this period.

Canis latrans.—About 6 miles south-southwest of Izucar de Matamoros, on the night of 30 December a coyote was seen crossing a road.

Urocyon cinereoargenteus.—Gray foxes were seen near Izucar de Matamoros on the road to Oaxaca on the nights of 1, 3 and 9 January and presumably were abundant in this region. Although steel traps baited with meat were set, none was collected.

Bassariscus astutus.—A cacomistl was seen at night on the Pan-American Highway in the hills southeast of Izucar de Matamoros between the villages of Tepenene and Los Amates on 9 January. It climbed a steep bank bordering the road, stopped and looked in our direction and then disappeared in the brush.

Nasua narica.—The remains of a coati were found in a cave 5 miles east of Izucar de Matamoros on 30 December, and are referable to *N. n. molaris.*

Spilogale putorius.—Spotted skunks were among the more common small carnivores in the vicinity of Izucar de Matamoros. Four specimens were trapped within 10 miles of the town in steel traps baited with bat carcasses, and Mr. Forbes saw one 5 miles from town and obtained another from a native living there. The first specimen I trapped, 5 miles east of Izucar de Matamoros, was extremely difficult to kill, and for more than two hours without sign of weakening it survived two .22 shorts and two .22 dust shots fired into the back at close range. It was finally killed by a heart puncture. The spotted skunks in this region are *S. p. tropicalis.*

Mephitis macroura.—A hooded skunk ran across the road about 6 miles south-southwest of Izucar de Matamoros on the night of 30 December. A local medical doctor who was hunting with us missed with his rifle and then chased the animal into a weed field where he attempted unsuccessfully and unfortunately to beat the skunk to death with the butt of his rifle. This hooded skunk had the stripes laterally, and subsequent specimens received from the Forbes family are also the laterally striped phase of *M. m. macroura.*

Conepatus mesoleucus.—On 29 December Dyfrig Forbes wounded a hog-nosed skunk on the road to Epatlan about 7 miles east of Izucar de Metamoros. It took refuge under the roots of a tree, and when we returned to the spot the next afternoon vultures had pulled the dead animal out but had not yet damaged the skin. Another hog-nosed skunk was found dead of a shotgun wound 4½ miles east of town, and these skunks were seen several times southeast of Izucar de Matamoros on the Oaxaca highway.

A servant at Forbes' house, watching me skin a hog-nosed skunk, informed me that its meat was considered to be a cure for acne; she refused, however, to accept the carcass of the animal despite the fact that she had rather bad acne on her cheeks and forehead.

Other carnivores presumed to occur in this part of Puebla are *Procyon lotor, Mustela frenata, Lutra annectens, Felis concolor* and *Lynx rufus.* None of these was seen. *Taxidea taxus* may also be found here and there was a specimen in the zoo in the city of Puebla, but I could not learn where it had been obtained.—Richard G. Van Gelder, *Dept. of Mammals, The American Museum of Natural History, New York 24, New York.* *Received 24 August 1959.*

SECOND SPECIMEN OF LEAST WEASEL FROM NORTH CAROLINA

An adult female least weasel, *Mustela rixosa allegheniensis,* died in the hand of Park Ranger A. L. Atchison, Blue Ridge Parkway, when he took it from a house cat at his residence, Balsam Gap, Jackson County, North Carolina, on 24 July 1959. Balsam Gap,

elevation 3400 ft., is approximately half-way between Sylva and Waynesville, North Carolina. The specimen was prepared as a study skin for the collections in Great Smoky Mountains National Park. (The park's southern boundary lies about 10 miles to the northwest.)

This appears to be only the second record for this little carnivore in North Carolina, the first having been taken 43 years previously near Marshall, some 32 miles to the northeast (Church, Jour. Mamm., 6: 281, 1925). The present specimen, therefore, is at the southernmost limit of its range. Total length is 172, tail 28, and hind foot 20 mm. Length of skull is 30 mm. Its color is walnut-brown above and white below, there being some brown mottling between the forelegs. The toes are white. The short tail is a uniform brown in color.—Arthur Stupka, *Great Smoky Mountains National Park, Gatlinburg, Tennessee. Received 8 September 1959.*

LONG-TAILED WEASEL CLIMBING TREES

Around 9:00 AM on 22 July 1959 I was checking snares set for snowshoe hares. When lifting a hare, which had recently died, out of the snare in which it was caught, a long-tailed weasel, *Mustela frenata*, suddenly appeared from under bushes of *Juniperus communis* and approached to within 2 feet. It did not appear to be the least bit alarmed by my presence and continued to search for the hare which I held in my hand. While the remaining snares were checked I left the hare 3 feet from the ground in a trembling aspen sapling. Returning after 5 minutes, I was just in time to see the weasel drag the hare into a juniper brush. In order to determine how adept at tree-climbing the weasel was, I left the hare 12 feet high in a large-toothed aspen of 3 inches dbh and retreated about 50 feet from the tree. The weasel searched unsuccessfully for the hare in circles up to 50 feet in diameter for about 5 minutes, although it passed close to the tree several times. It then apparently located the scent of the hare and sat on its haunches to look around. It failed to locate the hare, although the latter was not obstructed from the weasel's view. The weasel then continued the search for another minute and located the hare after sitting on its haunches again. It immediately climbed the tree, tried to pull the hare down, but was unsuccessful. It subsequently climbed an adjacent white pine and attempted to reach the hare from one of the side branches, again without success. It then climbed the aspen again and managed to pull the hare down. I replaced the hare on the same place in the tree, just to see how quickly the weasel would locate it the second time. This happened within a minute. This time the weasel was allowed to drag off the hare. It accomplished this without any trouble by pulling the hare (an adult) by the throat. After the weasel had dragged the hare for 15 feet I took it away. These observations indicate to me that the long-tailed weasel is probably equally as adept at tree-climbing as the related marten and fisher. It climbed down head first, as do its relatives.—Antoon de Vos, *Ontario Agricultural College, Guelph, Ontario. Received 1 September 1959.*

A RINGED SEAL FROM THE PRIBILOF ISLANDS, ALASKA

On 6 August 1951, Ford Wilke and I found a freshly dead ringed seal, *Pusa hispida*, on a small sand beach at the east end of Zapadni Rookery, St. Paul Island, Alaska. It was presumed to be a harbor seal, *Phoca vitulina*, and only the skin was preserved. The seal, a pup, weighed approximately 25 pounds. The blubber layer was about ¼ inch thick. Several subcutaneous bruises were noted on the body.

The specimen is now BDM 544 in the Fish and Wildlife Service collection. Comparison of the pelt with those of both harbor and ringed seals of comparable age reveals that it is a typical ringed seal in its first year.

This is the first ringed seal to be recorded from the Pribilof Islands. Since the pack ice frequently reaches the vicinity of the Pribilofs in winter and spring, it may seem strange

that ringed seals have not previously been recorded. Both the bearded seal, *Erignathus barbatus,* and the ribbon seal, *Histriophoca fasciata,* also typically associated with ice, are recorded, but rarely, at the Pribilofs (Preble and McAtee, N. Amer. Fauna 46, 1923; Hanna, Jour. Mamm., 4: 209–215, 1923). The superficial resemblance of the ringed seal to the harbor seal, the rarity of the former and the abundance of the latter at the Pribilofs, may explain the absence of the ringed from the Pribilof record.—KARL W. KENYON, *U.S. Fish and Wildlife Service, Sand Point Naval Air Station, Seattle 15, Washington.* *Received 15 September 1959.*

FOSSIL MANATEE FROM NORTH CAROLINA

According to Hatt (Bull. Amer. Mus. Nat. Hist., 66: 158), the Florida manatee, *Trichechus manatus latirostris,* reaches the northern limit of its range in Pamlico Sound, North Carolina. However, Brimley, in his annotated list "The Mammals of North Carolina" (Carolina Tips, Inst. No. 17, January 1946, Elon College, N. C.), lists a specimen taken near Duck Island in Currituck Sound in 1934, which extended the known range northward at least to Currituck Sound. The only other known record for the state is of another taken near Wrightsville Beach, New Hanover County, in 1919.

During the late fall of 1954, George Tregembo collected a fossilized lower jaw of a manatee at Fort Fisher, New Hanover County. This jaw, complete except for tooth crowns and rami, was embedded in a small deposit of rather heavily sanded shell rock, or coquina, which outcrops on the sea front near the tip of the Cape Fear Peninsula. The only other vertebrate remain known from this outcrop is the rostrum of a goosebeak whale, *Ziphius cavirostris* (McKeever, Jour. Mamm., 39: 440, 1958).

Richards (Bull. Geol. Soc. Amer., 47: 1611–1656, 1936) stated that this deposit is the most northerly coquina outcropping on the eastern coast of the United States and that it is probably contemporaneous with similar coquina which forms a part of the Anastasia formation in Florida. Wells (Jour. Elisha Mitchell Sci. Soc., 60: 129–134, 1944) dated the origin of this deposit to the Talbot Sea of Wisconsin Age (ca. 125,000 years ago). —JOHN B. FUNDERBURG, *Dept. of Zoology, Duke Univ., Durham, North Carolina.* *Received 20 October 1959.*

VELVET-ANTLERED PREGNANT WHITE-TAILED DOE

An antlered white-tailed doe deer, *Odocoileus virginianus,* was shot 14 December 1958 in Johnson County, Iowa. Similar cases of antlered female white-tailed and mule deer have been reported from various sections of the country by Buechner (1957), Diem (1958), Doutt and Donaldson (1959), Swank (1958) and Wislocki (1954, 1956). Information on breeding by the antlered does, however, is lacking for several of the specimens.

Velvet still covered the entire length of the Iowa doe's antlers. When the rack was first examined in detail six months after death, there were indications of the velvet having been alive at the time of death of the doe. The reproductive organs of the "odd-ball" doe were stored as a fresh-frozen specimen until studied in detail at the Wildlife Research Unit. This is the first reported occurrence of an antlered doe deer in Iowa, where 18,000 deer have been harvested since 1953.

Age of the doe, as determined from toothwear, was 3½ years. Antler beam lengths of 11.7 and 8.2 inches (Table 1; Plate I) are of a size that exceeds those found on many 1½- and 2½-year-old white-tailed bucks from the Lake States, the East and the Southeast. The size of the antlers, however, is small in comparison to the 10-point (5+5) mule deer doe rack reported by Swank (1958) from Arizona. External genitalia of the Iowa specimen were normal for a doe. There was milk in the udder, and a fawn was with the doe when she was shot.

TABLE 1.—*Measurements of doe deer antlers according to Boone and Crockett Club scoring system*

Measurement		Left	Right
Number of points (1 in. or more)		1	2*
Tip-to-tip spread	7.5 in.	—	—
Greatest spread	8 in.	—	—
Inside spread of main beams	5.3 in.	—	—
Length of main beam		11.7 in.	8.2 in.
Length of first point		—	1.6 in.
Circumference 1 in. above base†		3.9 in.	3.9 in.
Circumference of pedicel†		2.7 in.	2.3 in.
Volume in cc.†		90	61

* Basal snag 0.8 in. also present.
† Data supplementary to Boone and Crockett.

Each horn of the uterus contained an embryo with chorionic membranes extending the entire length of the horn. Measurement of the embryos was difficult; apparently they had shrunk some as indicated by their rough or wrinkled form. Their size, however, was determined to have been between 7–8 mm. in length, rump to crown. This size indicates the doe was bred roughly 3½ weeks earlier, about 20 November, which date falls within the peak of the rut for deer in Iowa. The uterus appeared normal for older deer at this stage of pregnancy. Fluid capacity of the uterus was established at 100 cc. in addition to the estimated 25 cc. of uterine fluid already present.

Size of the ovaries is considered normal for does of this age at this season. Their measurements were: left—18.5 × 12.5 × 12 mm.; right—17 × 14 × 9.5 mm. One corpus luteum of the current pregnancy was found in each ovary, 10 mm. and 9.5 mm. in the left and right, respectively (Plate 1). The right ovary also contained three regressing

PLATE I

LEFT: Doe deer skull with antlers in velvet (field no. EWM-7). RIGHT: Ovaries of antlered doe with two embryos. Note the large, light-colored corpus luteum in each ovary, indicating the current pregnancy. Three small, dark, regressing corpora lutea of pregnancy of a year earlier were present but are not shown. (*Photo by L. Facto.*)

brown corpora lutea (1.5, 2.0 and 2.5 mm. in greatest dimension), indicating a previous pregnancy (1957–58 breeding season).

Information on this doe agrees with the conclusion of Wislocki (1956) that "antlered does of the genus *Odocoileus* are usually females that are normal and fertile and have given birth to young . . .", and "the velvet is retained."

This report is a contribution of the Iowa Cooperative Wildlife Research Unit, jointly sponsored by Iowa State University of Science and Technology, the Iowa State Conservation Commission, the Bureau of Sport Fisheries and Wildlife, and the Wildlife Management Institute. The cooperation of Ray Grabin, the hunter who made the specimen available, and of Elden Stempel and Paul Kline of the Conservation Commission, who routed the specimen to the Unit, is appreciated.—Arnold O. Haugen and Eldie W. Mustard, Jr.

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RECORDS OF BIGHORN HYBRIDS

There have been several reports of crosses between the bighorn or mountain sheep, *Ovis canadensis*, and other species. Gray (Mammalian hybrids, Tech. Comm. 10, Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh, 1954, p. 79) summarized records of crosses with the mouflon or Sardinian sheep, *Ovis musimon*, and with the domestic sheep, *Ovis aries*. An anonymous article (Calif. Wool Grower, 10 (45): 22–23, 1935) reported a hybrid lamb born to a domestic ewe on the Z Bar T ranch at Pitchfork, Wyoming. The experimental breeding of a domestic ewe and a bighorn ram at the Rex Bell ranch near Las Vegas, Nevada, was reported by Pulling (Jour. Wildl. Mgt., 9: 82–83, 1945). Two female lambs resulted, and both in turn produced lambs when bred back to their sire. Several instances in Colorado were recounted by Pillmore and Teague (Colo. Conserv., 4: 22–26, 1955). These all involved bighorn rams and domestic ewes. About 1919, such hybrids were born on the Hendricks ranch, on the west fork of the Troublesome Creek, and on the Coykendall ranch near Rand. In 1925, five hybrid lambs (now in the collection of the Denver Museum of Natural History) were born on the Robbins ranch near Jefferson, Park County. In 1946 and 1954 there were similar cases on the Carpenter ranch west of Gunnison; a bighorn ram apparently followed the sheep down from the summer range in the West Elk Mountains and sired at least ten hybrid lambs. The *Denver Post* of 6 February 1960 reported complaints of the same situation near Avon, Eagle County, Colorado; of approximately 30 such lambs born the previous spring, only one had survived. Other instances have been reported

(J. R. Udy, *in litt.*) of wild rams coming into domestic flocks on ranches near Hanksville, Wayne County, Utah.

These first-generation hybrids are reported as having light coats, often slightly tinged with tan, bald faces, longer legs and shorter tails than pure domestic lambs. Their pelage is often a mixture of hair and wool. Usually these hybrid lambs fail to live longer than a few months. Reduced fertility is reported in some that survive. However, hybrid ewes have matured and produced lambs at the end of their first year, rather than after two years as is customary with bighorn females.

The following account, recently unearthed in our files, bears on this subject. It was reported, under date of 6 May 1922, by M. E. Musgrave, formerly Predatory Animal Inspector (now retired) at Phoenix, Arizona, who also took the photographs (Plate I). There had been a local story of a supposed half-breed mountain sheep and domestic goat owned by a Papago Indian living at Quitovaquita, near Ajo, Arizona. This was investigated by Musgrave, who reported the story "as I got it from a Papago squaw who could speak very good English, and I am positive the story she told was absolutely correct."

About 1915 or 1916, an ordinary domestic ewe, rather tight-wooled and without horns, was given as a lamb to the Papago squaw. Musgrave's report continues: "The Indians turned the lamb out on the range with their goats, and the following year the ewe came in with a buck lamb [Plate I, *A, B*]. . . . The following year she came in with

PLATE I

Views of hybrid sheep, *Ovis canadensis* × *Ovis aries*. *A* and *B*, two views of half-breed ram; *C*, half-breed ewe, sister of ram above; *D* and *E*, two views of hybrid ewe, lamb of the one in *C* and probably sired by the ram above. (*Photos by M. E. Musgrave.*)

a ewe lamb [Plate I, *C*] probably by the same wild mountain sheep ram. This ewe lamb was allowed to run out with the goats and also with the brother, and she came in with a ewe lamb [Plate I, *D, E*]. That lamb is very probably by the brother, but possibly by a wild mountain sheep, as she shows no trace of the domestic sheep and looks very much like a deer except for the feet and head. At the present time the old ewe, that is the domestic ewe, has a lamb presumably by the half-breed domestic and mountain sheep, her son, as the lamb looks very much like a domestic sheep. On the other hand, the ewe shown [Plate I, *C*] has a ewe lamb very probably by the brother, which is a very beautiful little creature with eyes and build very much like the animal shown [Plate I, *D, E*]. She will have considerable dark markings on her and will have beautiful eyes." Musgrave further pointed out that all the hybrids had short tails, and that in the females illustrated the horns were wrinkly, rather white in one case and nearly black in the other.

We are indebted to Donald F. Hoffmeister and Lloyd W. Swift for advice in assembling these details.—Stanley P. Young and Richard H. Manville, *U.S. Fish and Wildlife Service, Washington 25, D.C.* *Received 3 November 1959.*

MOOSE RUNS FROM SANDHILL CRANE

During field observations of big game populations in western Wyoming, I have had the chance to see repeatedly one of the dominance questions between a giant mammal and a bird clearly and neatly settled.

In the early morning hours in July, the glistening stream bank revealed two bull moose, *Alces alces shirasi*, water-feeding and browsing along. The adjoining meadow, dripping with dew, showed two sandhill cranes, *Grus canadensis tabida*, eagerly watching their only chick, shepherding its every step and peck. Soon, the younger one of the two bull moose wandered off into the meadow to graze. When he made a turn in order to recross the clearing and follow his partner, he encountered the sandhill crane trio about 25 feet away. Like an epic of old, the cranes came to life. One, I assume the male, took over the aggression department. With screaming fury it hopped toward the startled young bull moose, who stopped in his tracks; in the meantime the other parent hurriedly but silently led the chick away into some willow shrubs for cover. The next moment saw the aggressor crane jump like a bullet into the face of the moose, causing him to wheel around and start a detour. When this detour came within 30 feet of the hidden chick, the other crane flew up and, still hovering in the air, hit the perplexed moose with the wing bow into face, neck and ears. Shaking head and velvet-covered antlers, violently the bull resumed his running detour and peace returned to the meadow.

Older bull moose on other occasions avoided the sandhill cranes on first vocal notice by changing direction. An immature cow moose was observed to ignore the warning cry of the parent cranes and to approach with lowered head, as if curious. When hit by the wingblow of the parent crane, the cow moose kicked and jumped, then took off as if stung by an insect, blowing the nose and shaking all over. Even a cow moose leading her young calf, ordinarily one of the most fearless creatures, cautiously detoured the crane family upon hearing the warning call.

The mobility and aggressive spirit of the sandhill cranes clearly outweighs the tremendous difference in size and weight between these creatures.—Margaret Altmann, *Biological Research Station, Moran, Wyoming.* *Received 24 September 1959.*

SOME NOTEWORTHY RECORDS OF ARKANSAS MAMMALS

Recently a dry, mummified specimen of a long-tailed shrew was brought to the writer for identification. The specimen was collected during the last week in May 1942 by F. D. Crooks of Rogers, Arkansas, at a point about 3 miles north of War Eagle, Benton County, Arkansas. According to Crooks, who was accompanied by W. J. Baerg and

R. W. Larimore, the shrew was captured by hand as it darted from beneath an overturned rock. Larimore (pers. comm.) states that the fresh specimen was identified as *Sorex longirostris*. The shrew was preserved in alcohol and later was sent to the U.S. Fish and Wildlife Service where it was identified, probably by H. H. T. Jackson, as *Sorex longirostris*. The specimen was returned to Crooks and has been in his private collection since that time but has never been reported. Crooks says that he removed five embryos from the shrew some time after it had been collected. This indicates that there probably was a small population of this species in the area at the time of its capture. The writer tentatively confirmed the previous identification of the specimen and sent it to C. O. Handley, Jr. at the U.S. National Museum for verification. Handley cleaned and removed the skull from the mummy and confirmed the identification as *Sorex longirostris*. He also compared it with other specimens and stated that it is apparently inseparable from other known populations of this species. The nearest marginal record of this shrew is from near Reelfoot Lake in western Tennessee (Kellogg, Proc. U.S. Nat. Mus., 86: 245–303, 1939). It appears that this specimen may represent the northwestern extreme of a sparse population extending across all of northern Arkansas and probably southeastern Missouri as well. In view of the presently known distribution of this species, it seems improbable that the specimen represents a relict population. The area in which the specimen was found, as well as all of eastern Arkansas, has been very poorly collected so it is probable that intensive collecting might turn up additional specimens. The present record extends the known range of this species about 200 miles west of the nearest recorded locality in western Tennessee. The specimen has been accessioned as number UAZM42-1 in the mammal collection of the University of Arkansas, Department of Zoology.

In 1956 the silver-haired bat, *Lasionycteris noctivagans*, was listed as hypothetical for Arkansas (Sealander, Amer. Midl. Nat., 56: 257–296). Since then an adult male and an adult female of this species have been taken. They were collected by Otis Hite in Cove Creek Valley, 15 miles south of Prairie Grove, Washington County, on 1 April and 3 May 1958. The specimens are in the zoology department collection (UAZM58-1 and UAZM58-15). Since 1956 three additional specimens of the evening bat, *Nycticeius humeralis*, also have been collected by Hite in the same locality. One of them was collected on 15 February 1958, indicating that this bat is probably flying at about the same time in the spring as the red bat, *Lasiurus borealis*, which has been collected in northwestern Arkansas as early as 2 February (UAZM58-8). The other two evening bats were collected on 3 May and 13 July 1958.

In addition to the specimens reported above, an unusual color variation of the Indiana myotis, *Myotis sodalis*, was collected by the writer in Salt Peter Cave, near Boxley, Newton County, on 8 April 1958 (UAZM58-14). The ears, uropatagium and wing membranes are black, while the body is covered with silvery-white fur with only a very faint dark band visible near the middle of the hairs, providing a striking color contrast with the black membranes. Two other bats of this species which showed white patches on the pelage were collected at the same time. When the cave was revisited approximately a year later no pied specimens could be found among the large number of *M. sodalis* present.—J. A. Sealander, Jr., *Dept. of Zoology, Univ. of Arkansas, Fayetteville.* *Received 3 August 1959.*

A METHOD FOR COMPARING CURVATURES OF SMALL SKULLS

Skull curvature has been used as a taxonomic character as well as an age character in small mammals (Goldman, N. Amer. Fauna 59, 1947; Bee and Hall, Univ. Kans. Mus. Nat. Hist., Misc. Publ. 8, 1956). Determination of the curvature in most instances is obtained by placing the skull against a protractor or by visual estimation. Accurate measurements are difficult to obtain by use of such methods. Likewise, differences in skull size change the position of reference points so that it is difficult to compare the curvatures of skulls of different sizes.

While working with a series of pocket gophers, a method was developed that overcame the above-mentioned difficulties. This method involves the use of a photograph enlarger (an Omega enlarger was used in my work). The skull is used as a "negative" with the light casting a shadow from which curvature measurements are taken. A small tab of adhesive tape is placed on the skull at the reference points, between which the curvature is to be measured, i.e., the posterior edge of the interparietal and the posterior end of the nasals. The skull is then placed on its side on a piece of glass so that the profile of the skull is perpendicular to the plane of the glass. A small piece of wax or clay will hold the skull in place. The glass plate and skull are then placed on the enlarger in the position of the negative.

A piece of white paper is placed below the enlarger in the position of the printing paper. Two marks, a convenient distance apart (ca. 100 mm.), are placed on the paper to correspond to the two reference points on the skull. With the skull in position and the enlarger light turned on, the enlarger head is moved up or down until the shadow formed by the skull is aligned with the reference points of the skull falling upon those on the paper.

With a sharp pencil, the outline of the skull is traced. By repeating the procedure with another skull comparisons can be obtained. Similarly, comparisons of series of different sexes or age classes, or from various localities, can be obtained. When comparing series, the use of a different colored pencil for each series facilitates distinguishing the curvatures. These tracings can be used to obtain angles or to describe the curvature.

If permanent records are desired, instead of tracing the outline of the skull, a piece of printing paper can be placed in position and exposed after the skull has been aligned with the reference points. In order to keep each resulting picture separate, the catalog number of the skull can be written on the glass plate beside the skull with a grease pencil. The number then appears on the picture and reference can be made back to the original skull. A portion of a clear millimeter rule (one with the units etched in black) can also be fixed to the glass to give a size reference for each skull. Since only a silhouette of the skull is desired, precise timing is not required for the exposure or development of the picture. This increases the speed of making the photographic copies. Curvatures as described above can then be obtained from the pictures by using tracing paper and copying the outline of each skull.—LOWELL L. GETZ, *Museum of Zoology, Univ. of Michigan, Ann Arbor.* *Received 18 August 1959.*

ERYTHROCYTES AND HEMOGLOBIN IN THE CRABEATER SEAL

While engaged in a study of the blood constituents of Antarctic fishes, the writer had incidental opportunity to examine blood samples from the crabeater seal, *Lobodon carcinophagus*. Erythrocyte counts and hemoglobin determinations for these seals are presented below.

Five crabeater seals, 4 to 6 feet in length, were collected off Cape Norvegia on the pack ice of the Weddell Sea, from 17 to 24 January 1959. The seals were shot in the neck and the blood collected from the fountainlike outflow of the jugular vein into jars containing a small amount of sodium citrate. Erythrocyte counts were made with a Levy-Hausser hemocytometer and a 1:200 dilution with Toissons solution. Hemoglobin content was estimated with a Haden-Hausser clinical model hemoglobinometer, using a 1:20 dilution with n/10 HCl.

The large amounts of blood available made possible the counting of 160 hemocytometer squares for each of four separate samples taken from each of the five seals, as well as two hemoglobin determinations for each of the samples. The average numbers of erythrocytes, in millions per mm^3, for the five seals were 4.55, 4.10, 4.38, 4.52 and 4.52. The hemoglobin determinations, in the same order, were 18.0, 18.0, 18.5, 18.5 and 18.0 grams per 100 cc. of blood. The round erythrocytes had a diameter of about 9 microns.

Though data are not available for other Antarctic seals, it appears that these amounts of erythrocytes and hemoglobin are relatively normal, being neither excessively high nor low in comparison to non-Antarctic seals and other mammals (Prosser, Comparative Animal Physiology, ix+888 pp., 1950; Spector, Handbook of Biological Data, xxxvi+584 pp., 1956).—JAMES C. TYLER, *Natural History Museum, Stanford Univ., California. Received 6 October 1959.*

A TECHNIQUE FOR INCREASING THE TIME OF DYE RETENTION IN SMALL MAMMALS

The use of dyes in tracing the movements of small mammals has been described by New (Jour. Mamm., 39: 416–429, 1958). The usefulness of this technique for tracing the activities of a single individual, however, depends upon the length of time during which dyed scats were passed, and upon the activity of the animal during that time.

To test the possibility of increasing the time of dye retention, a series of *Peromyscus leucopus*, obtained in the wild, was fed in the laboratory with various mixtures intended to increase the length of time required for the dye to travel through the digestive tract. In each experiment, a check mixture of dyed rolled oats was fed to one individual. Of the mixtures tried, the one which showed most promise consisted of 5 grams of rolled oats, .5 gram of Fast Green FCF, and Kaopectate to moisten thoroughly.

Several trials showed that color in the scats of deer mice fed this mixture could be detected 60 to 72 hours after ingestion, as opposed to a maximum of 36 hours for plain dyed rolled oats. Placing the scats in water was essential for distinguishing dyed scats near the end of the period. The constipating effect of the Kaopectate, of course, reduced the total number of droppings passed during any given period, which would be disadvantageous in attempting to determine activities of the animal.

Field tests of this technique remain to be performed, but it seems likely that most small mammals cover their normal territory and home range quite thoroughly within a 72-hour period. If significant numbers of scats could be recovered, the activities of a single individual should be determinable by this method.—THOMAS HARESIGN, *Univ. of Massachusetts, Amherst. Received 23 October 1959.*

REVIEW

Mosby, Henry S., *Ed.* MANUAL OF GAME INVESTIGATIONAL TECHNIQUES. The Wildlife Society. Pp. xxii + 345, 142 figs., 102 tables. 1960. Price, $4.50.

The science of wildlife management, as we know it today, was nurtured largely by the efforts of Aldo Leopold and really came of age with the publication of his *Game Management* in 1933. It has matured to the point where it has a respectable literature of its own, a quarterly journal devoted to its affairs, and a specialized curriculum in at least fifty American colleges and universities. It has its own professional society, is officially recognized by employment agencies, and it exerts considerable influence in private, state and federal conservation agencies. As an applied science, game management depends on such disciplines as biology, geology, mathematics, chemistry and physics, sociology, land economics, agriculture and forestry. As in all science, its approaches to a problem

involve gathering and classifying data, analyzing this information, interpreting and verifying it by controlled experiment, and reporting the results. The techniques employed in these operations are necessarily diverse.

In this volume—the work of the seven members of the Wildlife Techniques Committee appointed in 1957—is a summary and description of the best-known field and laboratory techniques currently applied in the management of game birds and mammals. An attempt is made, not to catalogue all techniques nor prescribe any single, standard procedure, but rather to report and illustrate methods that have been found of value. This represents a sifting of the literature through early 1959, plus the unpublished contributions of many individuals. Contents include consideration of record keeping, reconnaissance mapping, habitat evaluation, estimates of numbers, criteria of sex and age, population analysis, methods of preservation, post-mortem examinations, capturing and marking methods, measures of mortality, control of nuisance species, food habits procedures, presentation of numerical data, use of literature, project planning, and reporting research results. The bibliographic section lists 781 titles; the Appendix offers tables on clutch size and hatching success of game birds, gestation periods of selected mammals, and a list of North American birds with A.O.U. numbers and recommended band sizes. Other helpful tables in the text pertain to control measures, repellents, colors for use in marking, anesthetics, sedatives and tranquilizers, chemical preservatives, terms used in population analysis, selected life tables, tooth eruption and replacement, stages in fetal development, and population estimates.

In the Foreword, it is stated that "This volume is designed for use by the practicing field biologist, by the wildlife administrator, and by college instructors of wildlife management. It is our thinking that this publication should serve as a techniques reference to the wildlife biologist, especially where his field of endeavor changes from one species of wildlife to another. We hope the wildlife administrator will find this book helpful when he must appraise the soundness and costs of research projects proposed by his staff. Finally, it is anticipated that the college instructor teaching courses in wildlife techniques will use this manual—with appropriate local departures—as a text and reference." The book is carefully planned and assembled and should realize many of these lofty aims.

This volume is well printed and sturdily bound; the illustrations are well reproduced. The system of pagination by sections instead of in one continuous sequence seems unnecessary in a volume of this size. The picture of a cannon net trap is needlessly duplicated on pages 10:12 and 12:17. The photo-offset method of printing produces unjustified margins, but is practical for a book that probably will be revised frequently; its greater economy permits selling the book on a break-even basis at a reasonable price. It is this reviewer's impression that offset printing, in contrast to letterpress, has a greater inherent tendency to such slips as Acknowledgements, Clarke's Nutcracker, laquer, Mustellidae, phamplets and Raindeer, and to such inconsistencies as Pronghorn Antelope, Prong-horn Antelope, Pronghorn and simply Antelope. Still, these are all minor matters and do not seriously affect the book's excellence. We predict it will be widely used in both teaching and practice, and will stimulate further attention to techniques in wildlife investigations. Copies may be ordered from The Wildlife Society, c/o Virginia Cooperative Wildlife Research Unit, Department of Forestry and Wildlife, Virginia Polytechnic Institute, Blacksburg, Virginia.—RICHARD H. MANVILLE.

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PERSONAL NOTICES

(continued from p. 505)

FOR SALE—Live desert rodents. Send for information and price list. Keith E. Justice, 44 W. Rillito St., Tucson, Arizona.

KEY TO THE SKULLS OF NORTH AMERICAN MAMMALS, by Bryan P. Glass, has been reprinted and may be ordered from the Research Foundation, Oklahoma State University, Stillwater, Oklahoma. Price $2.00 as in the past.

URGENTLY NEEDED—*Serum of foreign pinnipeds* for a comparative study involving electrophoretic and immunologic work on pinnipeds of the world. Directions for preservation and shipping sent on request; we assume shipping costs. Murray L. Johnson, Museum of Natural History, University of Puget Sound, Tacoma 6, Washington, U. S. A.

FOR *Sherman Live Traps* write H. B. Sherman, P.O. Box 683, De Land, Florida.

ALL-PETS MAGAZINE is written for hobbyists, breeders, fanciers and people engaged in pets for profit; covers all unusual livestock kept as pets, plus aquaria, cage and aviary birds, cats and dogs; subscription $3.50 per year. Manuscripts solicited from ASM members. Established 25 years, circulation world-wide, 80 pages and up monthly. We also publish books on pet livestock; some 80 titles now. National distributors of some 350 books on pets. Write for free book circular to Frank Dittrich, 139 Darling Place, Fond du Lac, Wisconsin.

FOR SALE—*Transactions San Diego Society of Natural History*, complete set, Vols. 1–11 with Vol. 12 in progress, newly bound in blue buckram, $125. L. M. Huey, Natural History Museum, Balboa Park, San Diego 1, Calif.

COMMENTS AND NEWS

REPORT OF THE COMMITTEE ON NOMENCLATURE

American Society of Mammalogists

COMMITTEE: William H. Burt, *Chairman*, Stephen D. Durrant, E. Raymond Hall, Charles O. Handley, Jr., Philip Hershkovitz, Donald F. Hoffmeister, Barbara Lawrence, Randolph L. Peterson, Henry W. Setzer, Richard G. Van Gelder.

I. QUESTION: Shall *Dama virginiana* Zimmermann and other American deer of the same genus bear the generic name *Dama* Zimmermann, 1780, or the generic name *Odocoileus* Rafinesque, 1832?

Majority Report:

1. The Majority recommends the conservation of the generic name *Odocoileus* Rafinesque, 1832, for the whitetail deer, *Dama virginiana* Zimmermann, by:
   a. Placing the generic name *Odocoileus* Rafinesque, 1832 (Atlantic Journal, 1: 109), with type species, by monotypy, *Odocoileus speleus* Rafinesque, on the OFFICIAL LIST OF GENERIC NAMES IN ZOOLOGY.
   b. Placing the specific name *Dama virginiana* Zimmermann (1780, Geogr. Geschichte, 2: 129) on the OFFICIAL LIST OF SPECIFIC NAMES IN ZOOLOGY.
   c. Suppressing the generic name *Dama* Zimmermann, 1780 (Geogr. Geschichte, 2: 129), by placing it on the OFFICIAL INDEX OF REJECTED AND INVALID GENERIC NAMES IN ZOOLOGY.
2. The Majority also recommends that the name *Dama* for the fallow deer, *Cervus dama* Linnaeus, be conserved by:
   a. Placing the name *Dama* Hamilton Smith, 1827 (Griffith's Animal Kingdom, 5: 306), with type species *Cervus dama* Linnaeus, on the OFFICIAL LIST OF GENERIC NAMES IN ZOOLOGY.
   b. Placing the name *Platyceros* Zimmermann, 1780 (Geogr. Geschichte, 2: 129), with type species *Platyceros dama* Zimmermann (= *Cervus dama* Linnaeus), on the OFFICIAL INDEX OF REJECTED AND INVALID GENERIC NAMES IN ZOOLOGY.

The recommendation of the Majority is an endorsement of Cabrera's "Counter-Proposal to Certain Portions of Dr. T. C. S. Morrison-Scott's Application [to the International Commission on Zoological Nomenclature] Regarding the Stabilization of the Generic Name for the Virginia Deer of America," 1954, Bulletin of Zoological Nomenclature, vol. 9, part 10, pp. 299–300.

Argument.—The Majority recognizes that *Odocoileus* for the whitetail deer has become firmly entrenched in current usage and widely circulated in the scientific and lay literature of the last 50 years. In contrast, *Dama* Zimmermann was not recognized for over 150 years and never generally accepted after its revival in 1948. Furthermore, the name *Dama* of later authors, beginning with Hamilton Smith, 1827, has been consistently used as the scientific name for the well-known fallow deer for well over 100 years, and also as the common text name of the same animal for over 200 years.

Replacement of *Odocoileus* by *Dama*, the name universally and consistently, albeit erroneously, used for the fallow deer would not only entail confusion, discontinuity, and hardships, but the act would run counter to the purpose, if not the letter, of the Rules of Zoological Nomenclature.—*Signed*, WILLIAM H. BURT, STEPHEN D. DURRANT, CHARLES O. HANDLEY, JR., PHILIP HERSHKOVITZ, DONALD F. HOFFMEISTER, BARBARA LAWRENCE, R. L. PETERSON, HENRY W. SETZER, RICHARD G. VAN GELDER.

Minority Report:

1. The Minority recommends *Dama* as the generic name of North American deer.

Argument.—*Dama* is recommended because of a regard for stability of zoological nomenclature. *Dama* is thought to have priority (to be the earliest available name), and adherence to the Law of Priority is thought to be the shortest road to stability. *Dama* has been used at

one time or another for at least 11 named kinds of North American deer and therefore is familiar to many persons who use technical names for those deer. Indeed the "trivial" names of two kinds of American deer, *Dama virginiana virginiana* and *Dama virginiana rothschildi*, were proposed in combination with the generic name *Dama* instead of in combination with some other one of the several generic names used for American deer. Experience has shown that any inconvenience caused by using *Dama* in place of *Odocoileus* and by using some other name for the fallow deer would be of short duration and soon forgotten. Application of the Law of Priority enables the zoologist to apply names with greater degree of certainty as to their stability than does the application of other devices so far proposed, and enables the zoologist to apply names without the delay inherent in other devices. Making exceptions to the Law of Priority in deference to expediency at some particular time returns to the criterion that caused most of the instability that existing rules for zoological nomenclature were designed to correct. Some persons, it is true, favor instead of the Law of Priority the preparation of a list of *nomina conservanda*. With the sanction of the International Commission on Zoological Nomenclature a start has been made on such a list. But, the Commission's recent (Direction 79) changing of the name of the South American otter from *Lutra sambachi* (Gray), already on the list of *nomina conservanda*, to *Lutra brasiliensis* (Gmelin), which had priority, emphasizes that stability is more readily attained by adherence to the Law of Priority.—*Signed*, E. Raymond Hall.

At its Fortieth Annual Meeting, the American Society of Mammalogists endorsed the Majority Report and rejected the Minority Report by a vote of 74 to 1.

II. Question: Shall *Mus citellus* Linnaeus and other ground squirrels of the same genus bear the generic name *Spermophilus* F. Cuvier, 1825, or *Citellus aucts.*?

Majority Report:

1. The Majority recommends the conservation of the generic name *Citellus* J. A. Allen, 1902, for the ground squirrel, *Mus citellus* Linnaeus, by:
   a. Placing the generic name *Citellus* J. A. Allen, 1902 (Bull. Amer. Mus. Nat. Hist., 16: 375), with type *Mus citellus* Linnaeus, by monotypy, on the Official List of Generic Names in Zoology.
   b. Establishing that the name *Citellus*, cited from J. A. Allen, 1902, shall, for purposes of homonymy and synonymy, be treated as if published 1 January 1758.
2. Further, the Majority recommends that the generic name *Spermophilus* Cuvier, 1825 (Dents des Mammiferes, p. 255), with type *Mus citellus* Linnaeus, be placed, by monotypy, on the Official List of Generic Names in Zoology as an objective junior synonym of *Citellus* J. A. Allen, 1758 (1902).

Argument.—The Majority holds that usage of *Citellus* by a preponderant number of biologists of many disciplines during the last five decades, and its use in most major works on mammals in Asia, Europe, and North America, has so firmly established the name that its replacement by another would lead to confusion, particularly among non-mammalogists.

That the name *Citellus* of Oken, 1816, is not valid is irrelevant. *Citellus* was properly introduced by J. A. Allen in 1902, and is valid from that author and date irrespective of the fact that authorship and date were first attributed to Oken, 1816. The Majority acknowledges the validity of *Spermophilus* Cuvier, 1825, on a strictly priority basis. However, the Majority holds that retention of the name *Citellus* would be in conformance with the purpose of the Rules of Zoological Nomenclature. Further, strict adherence to the Law of Priority is but one of the methods of achieving stability in scientific nomenclature. —*Signed*, William H. Burt, Stephen D. Durrant, Donald F. Hoffmeister, Barbara Lawrence, R. L. Peterson, Henry W. Setzer.

Minority Report:

1. The Minority recommends use of the generic name *Spermophilus* F. Cuvier, 1825, for *Mus citellus* Linnaeus and for other ground squirrels of the same genus.

Argument.—The Minority holds that *Spermophilus* Cuvier, 1825, appears to be the first valid name that came into general use for the spermophiles or ground squirrels. This name was almost universally used until 1902 when the competing name *Citellus*, cited from Oken, 1816 (Lehrbuch der Naturgeschichte, 3[2]: 842), was introduced into the literature by J. A. Allen. The name *Spermophilus*, however, regained its nomenclatorial ascendency among many taxonomists and other zoologists after it was shown that *Citellus* Oken was nonbinomial and that the work from which it is cited was non-Linnaean and was placed by the International Commission on the OFFICIAL INDEX OF REJECTED AND INVALID WORKS IN ZOOLOGICAL NOMENCLATURE. The claim that real confusion and hardship would ensue if the invalid synonym *Citellus* were completely replaced by the valid name *Spermophilus* has no basis in fact. Both names, now as always, refer to one and the same animal. Continued use of the name *Spermophilus* is in conformity with the International Rules of Zoological Nomenclature and requires no sanction by the International Commission. —*Signed*, E. RAYMOND HALL, CHARLES O. HANDLEY, JR., PHILIP HERSHKOVITZ, RICHARD G. VAN GELDER.

At its Fortieth Annual Meeting, the American Society of Mammalogists endorsed the Majority Report and rejected the Minority Report by a vote of 55 to 20.

A. S. M. HONORARIA

Two honoraria are available each year for young mammalogists who have not obtained the Ph.D. degree. Each honorarium carries a stipend of $100 to help defray expenses of travel to the annual meeting for the presentation of the paper. The next meeting will be held at the University of Illinois, 12–15 June 1961. Entries should be submitted to Dr. Emmet T. Hooper, Museum of Zoology, University of Michigan, Ann Arbor, before 1 April 1961.

TO FOREIGN MEMBERS

The Society will hold its next annual meeting at the University of Illinois, Champaign, 12–15 June 1961. The attendance of foreign members may be facilitated by a special letter of invitation from the Society. Requests for such letters should be addressed to the President, Dr. Stephen D. Durrant, Department of Zoology, University of Utah, Salt Lake City, Utah, together with suggestions as to content and officials to whom the letters should be directed.

NOTE TO ALL CONTRIBUTORS

Your editor has had the pleasure of serving on a joint Committee on Form and Style of the Conference of Biological Editors and the American Institute of Biological Sciences. The Conference, representative of over 60 American biological journals, has been interested in standardizing such matters of style as abbreviations, citations, typography, and general usage in biological publications. The deliberations of this Committee, over the past several years, have resulted in the publication of a STYLE MANUAL FOR BIOLOGICAL JOURNALS. It is scheduled to appear at about the date of this issue, and we urge all contributors to this Journal to consult it in their preparation of manuscripts. Copies may be ordered from the American Institute of Biological Sciences, 2000 P Street, NW, Washington 6, D.C.

NEW AFRICAN PUBLICATION

Growing interest in the study and conservation of the dwindling African fauna is exemplified by the appearance of an attractive new journal, *The Lammergeyer*. This fulfills an ambition of The Natal Parks, Game and Fish Preservation Board since its establishment in 1947. Volume 1, No. 1, running to 44 pages, appeared in May 1960. It is devoted largely to two fine articles on the square-lipped rhinoceros, *Ceratotherium*

simum, but also contains a number of miscellaneous notes of general natural history interest. Our best wishes go to this new publication in a kindred field. Copies are obtainable at 2/6 from The Secretary, P.O. Box 662, Pietermaritzburg, Union of South Africa.

DEATH OF BOURDELLE

Word has been received of the death of Dr. Édouard Bourdelle on 16 June 1960. He served as Head of the Laboratoire des Mammifères et Oiseaux at the Muséum National d'Histoire Naturelle, Paris; he was a founder of the journal *Mammalia*; he will perhaps be best remembered for his contributions to the mammal volumes in the *Traité de Zoologie* edited by De Grasse.

DEATHS REPORTED

Leonard M. Llewellyn, 22 September 1960

William M. Mann, Life Member, 10 October 1960

OBITUARY NOTICE

Angel Cabrera (1879-1960)

The death of Doctor Angel Cabrera Latorre, Charter Member of this Society, on 7 July 1960, marked the passing of one of the world's great mammalogists.

Dr. Cabrera was born 19 February 1879, in Madrid. After receiving his doctorate from the University of Madrid, in 1902, he accepted the honorary post of assistant naturalist in the National Museum of Natural Sciences, Madrid. During the course of his affiliation with the Museum he produced the classic "Fauna Ibérica: Mamíferos" (1914), "Los Mamíferos de Marruecos" (1932), "Genera Mammalium" (1919–1925), "Manual de Mastozoología" (1922) and other standard works consulted the world over.

In 1925 Dr. Cabrera accepted the professorship offered him by the National University of La Plata, Argentina. From 1927 to 1947 he was professor and head of the Department of Paleontology in the Museum of La Plata. During the same period he held the chair of professor of zoology in the School of Agriculture and Veterinary Medicine of the University of Buenos Aires. He also made a number of field trips to various parts of his adopted country for the purpose of studying and collecting specimens of living and fossil mammals.

In 1940, Dr. Cabrera published, in collaboration with Dr. José Yepes, the well-known and authoritative "Mamíferos Sudamericanos." The first part of Cabrera's great opus "Catálogo de los Mamíferos de la America del Sur" appeared in 1957 (1958). It was while putting the finishing touches to the second part of his catalog that he was stricken. It is hoped to have the final installment printed before the end of this year.

Dr. Cabrera's publications include 218 scientific papers on living and extinct mammals, 27 books on mammals and more than 400 popular articles on biology. He was skilled in art and animal portraiture and often illustrated his own scientific articles. Among the many honors and distinctions conferred upon Cabrera during his lifetime were his election as Corresponding Member of the Zoological Society of London in 1907, and Honorary Foreign Member in 1947, Commissioner of the International Commission of Zoological Nomenclature since 1930, election to membership in the Royal Academy of Physical and Natural Sciences of Madrid since 1931, and honorary membership in the American Society of Mammalogists since 1947. In his later years, Dr. Cabrera was a collaborator and honorary associate of the Museo Argentino de Ciencias Naturales.—Jorge A. Crespo.

FORTIETH ANNUAL MEETING

FORTIETH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

19–23 June 1960

The fortieth annual meeting of the American Society of Mammalogists was held at Pacific Lutheran College, Tacoma, Washington, 19–23 June 1960.

The local committee was composed of Murray L. Johnson and Burton T. Ostenson, Co-Chairmen, Leo K. Couch, Arthur S. Einarsen, Louis P. Hoyer, Robert A. Kallsen, Karl W. Kenyon, Harold J. Leraas, Frank Richardson, Victor B. Scheffer and Ford Wilke.

PROGRAM

SUNDAY, 19 JUNE

4:00–10:00 PM—Registration, College Union Building
6:00 PM—Directors' Meeting. Dinner, followed by business session, at the Murray L. Johnson residence, 501 North Tacoma Avenue

MONDAY, 20 JUNE

8:30 AM—Registration, Classrooms Building
9:00 AM—Morning Session

Welcome: Dr. S. C. Eastvold, President, Pacific Lutheran College.
Response: Dr. Robert T. Orr, President, American Society of Mammalogists.

1. Effect of isolation at room temperature on the adaptability of laboratory mice (*Mus musculus*) to low ambient temperatures. William Prychodko, Detroit Institute of Cancer Research, Detroit, Michigan.
2. Thermal regulation in two species of *Peromyscus*. Martin Murie, University of California, Berkeley.
3. Glandular and cytochemical specializations and trends in the heteromyid rodents. W. B. Quay, University of California, Berkeley.
4. The history and philosophy of mammal control. Stanley P. Young, U.S. Fish and Wildlife Service, Washington, D.C.
5. Sensory perception in *Geomys bursarius*. George E. DeCoursey, Jr., University of Wisconsin, Madison.
6. The renal anatomy of the primitive rodent *Aplodontia rufa*, and a consideration of its functional significance. E. W. Pfeiffer, Montana State University, Missoula.
7. Climate and breeding in one subfamily of mammals. Joseph C. Moore, American Museum of Natural History, New York.
8. Population trends in the northern fur seal. Douglas G. Chapman and Ford Wilke, U.S. Fish and Wildlife Service, Seattle, Washington.

1:00 PM—Afternoon Session

Address—Account of a recent trip to the U.S.S.R. Ian McT. Cowan, University of British Columbia, Vancouver.

1:20 PM—Symposium on Russian-American exchanges in mammalogy.
E. W. Pfeiffer and R. S. Hoffman, Co-Chairmen.

Panel members:
Rollin H. Baker, Michigan State University
James S. Findley, University of New Mexico

Emmet T. Hooper, University of Michigan
William O. Pruitt, University of Alaska
Andrew Starrett, University of Southern California
Richard G. Van Gelder, American Museum of Natural History

There was a display of literature and specimens received on exchange from the U.S.S.R. by members of the Society.

6:30 PM—Smorgasbord and Smoker—College Union
8:30 PM—Showing of Russian films—Parkland Theater:
Hunting in Siberia.
Wolf Hunt.

TUESDAY, 21 JUNE

9:00 AM—Morning Session

9. Mammals of the Cape Thompson region, Alaska. William O. Pruitt, University of Alaska, College.
10. The axis deer problem in Hawaii. William Graf, San Jose State College, San Jose, California.
11. Mammals of Flaming Gorge. Stephen D. Durrant, University of Utah, Salt Lake City.
12. A life history study of the Indiana bat, *Myotis sodalis*. John S. Hall, University of Illinois, Urbana. (This paper was awarded an honorarium.)

10:30 AM—Annual Business Meeting, Election of Officers
1:00 PM—Group Photograph, east steps, Chapel-Music-Speech Building

1:20 PM—Afternoon Session

13. Mammals of the Guadiana lava field, Durango, Mexico. Rollin H. Baker, Michigan State University, East Lansing.
14. Life history of the dusky tree mouse, *Phenacomys silvicola*. Percy Clifton, Yamhill, Oregon.
15. The last permanent brown bear population in Norway. Kaare Elgmork, Yale University, New Haven, Connecticut.
16. A study of the eastern harvest mouse, *Reithrodontomys h. humulis*. Stephen V. Kaye, North Carolina State College, Raleigh. (This paper was awarded an honorarium.)
17. Distribution and status of the hoary marmot (*Marmota caligata*) in Montana. Philip H. Wright, University of Montana, Missoula, and Clinton H. Conaway, University of Missouri, Columbia.
18. Growth and nutrition in the beaver. Ian McT. Cowan, University of British Columbia, Vancouver.
19. Aggressive behavior in the pouched rat, *Cricetomys gambianus*. Joseph A. Davis, New York Zoological Park, New York.
20. Reproductive biology of the Australian bush rat, *Rattus assimilis*. J. Mary Taylor, Wellesley College, Wellesley, Massachusetts.

5:00 PM—Open House, mammal collections, Puget Sound Museum,
Howarth Hall, University of Puget Sound.
6:30 PM—Annual Banquet, University of Puget Sound Student Center

Welcome: Dr. Franklin Thompson, President, University of Puget Sound.
Address: A bird's-eye view of mammalogy. Dr. Robert C. Miller, President, California Academy of Sciences.
Film: Sea Otter. H. Robert Krear, Boulder, Colorado.

WEDNESDAY, 22 JUNE

9:00 AM—Morning Session

21. Australasian Tertiary marsupials. R. A. Stirton, University of California, Berkeley.
22. The water rats (Hydromyinae) of New Guinea. Hobart M. Van Deusen, American Museum of Natural History, New York.
23. Extinction of a prairie-dog colony. R. R. Lechleitner and Jules V. Tileston, Colorado State University, Fort Collins.
24. Urinary amino acids of non-human primates. Jack Fooden, University of Chicago, Chicago, Illinois.

10:30 AM—Final Business Session
1:00 PM—Afternoon Session

25. The classification of mammals. W. H. Burt, University of Michigan, Ann Arbor.
26. Ecological and evolutionary relationships of the montane and Mexican voles in the Southwest. James S. Findley, University of New Mexico, Albuquerque.
27. Systematics of the genus *Macrotus* (Chiroptera). Sydney Anderson and Craig E. Nelson, University of Kansas, Lawrence.
28. Relationships of woodrats as indicated by the male phallus. Emmet T. Hooper, University of Michigan, Ann Arbor.
29. The systematic status of *Thomomys monticola*. Seth B. Benson, University of California, Berkeley.
30. Adiaspiromycosis in mammals. W. L. Jellison, Rocky Mountain Laboratory, Hamilton, Montana, and Chester W. Emmons, National Institutes of Health, Bethesda, Maryland.
31. The role of environmental factors in regulating animal activity rhythms. Patricia DeCoursey, University of Wisconsin, Madison.
32. The efficiency of some baits used in trapping small mammals. James R. Beer, University of Minnesota, St. Paul.
33. Studies of population growth in an island population of *Microtus*. William Z. Lidicker, Jr., University of California, Berkeley.

3:45 PM—Film: Mammals of Northwestern Oregon. Presented by Wesley Batterson, Oregon State Game Commission.
7:30 PM—Film: Caribou Year. Presented by W. O. Pruitt, followed by an informal symposium on arctic mammals.

THURSDAY, 23 JUNE

Field Trips: Mount Rainier National Park, Olympic National Park

DIRECTORS' MEETING

The Directors of the American Society of Mammalogists met at 8:20 PM, 19 June 1960, in the residence of Dr. Murray L. Johnson, 501 North Tacoma Avenue, Tacoma, Washington, following a delightful dinner prepared by Mrs. Johnson. The minutes of the previous Directors' meeting were read and approved. The report of the Secretary-Treasurer was read and approved. A list of 168 names of new members was approved for recommendation to the Society for election; 47 were noted to be dropped from membership for failure to pay dues for three consecutive years; and 50 resignations were reported. The financial statement for the year was presented and approved. Total expenditures for the year 1959 amounted to $15,819.73, income for the same period totaled $18,610.92. The report of the auditor was read and approved. The report of the Trustees was presented by Harris and approved. Burt reported that the Committee on Honorary Memberships is recommend-

ing no candidates this year. The report of the Editor was presented and approved. The question was raised of advertising rates in the *Journal*; the Secretary-Treasurer was authorized to ascertain the range of rates charged by other journals, and to set a reasonable rate which would best serve the interests of the Society. Burt (Chairman), Manville and Storer were appointed as a committee to consider possible changes in the design for the cover of the *Journal of Mammalogy*.

The following budget was approved for 1960:

Expenses of the Journal of Mammalogy	$11,000.00
Expenses of the Executive Office	2,000.00
Editorial expenses	150.00
Membership Committee expenses	50.00
Index Committee expenses	35.00
Honoraria	200.00
AIBS	200.00
Zoological Record	100.00
IUCN	50.00
Contingent Fund	215.00
Total	$14,000.00

President Orr announced that S. S. Gregory would no longer be able to serve as Trustee; H. M. Van Deusen was appointed to fill the vacancy. The Trustees were authorized to make any changes in the method of handling investment funds that would serve the interests of the Society. The Secretary-Treasurer was instructed to write a letter to Steve Gregory, expressing the gratitude of the Society for his diligent service. Richard H. Manville and Bryan P. Glass were reappointed Editor and Secretary-Treasurer, respectively. Transfer of $985.00 from the income of the J. A. Allen Memorial Fund and $2,765.96 from the income of the Endowment Fund to the checking account, for the publication of the *Journal*, was authorized. The Secretary-Treasurer was authorized to transfer $1,821.81, from the sale of back numbers and life memberships, to the Trustees for investment. The report of the Index Committee was approved, and the committee was instructed to proceed with the publication of the second 10-year index. Donald Hoffmeister reported the successful negotiation of a contract with the Walter J. Johnson Reprint Corporation for reprinting out-of-print issues of the *Journal*. President Orr announced that Harold Coolidge had been appointed as the Society's representative to the National Academy of Sciences. A request that we affiliate with the International Science Foundation was tabled. Antoon de Vos was appointed representative to the Committee on Agricultural Pests of the National Research Council. A new committee was authorized to establish and maintain contact with mammal societies in other parts of the world. The meeting adjourned at 11:45 PM.

ANNUAL BUSINESS MEETING

The 40th Annual Business Meeting convened at 11:10 AM, 21 June, in the Classrooms Building of Pacific Lutheran College, with 104 members present. Minutes of the previous meeting were read and approved. The names of 168 applicants for membership were presented and approved. The deaths of 15 members, including four Life Members (*), were announced: Hiram B. D. Blauvelt,* Philip M. Blossom,* James D. Bump, Ira D. George, Robert M. Hedrick, Arthur W. Henn, Lawrence E. Hicks,* S. Paul Jones, Otis M. King, Marcel L. LeGrand, Gustavus D. Pope,* William R. Rawlings, Albert C. Rogers (Charter Member), Amon R. Shearer and Paul E. Tovey. The Treasurer's report, audit, and Trustees' report were presented and approved.

The following statistical summary of memberships and subscriptions was presented:

Membership		
Changes since last report:	*Minus*	*Plus*
Nominees (Includes 118 members elected 22 June 1959)		286
Resignations	50	
Deaths reported	15	
Dropped, delinquent	47	
	112	286
Net gain		174
Status of members as of 31 March 1960:		
Honorary		8
Life		115
Honorary and Life		3
Emeritus		9
Annual		1,630
Total		1,765
Subscriptions		609
New		59
Cancelled		29
Net Gain		30
Mailing list as of 31 March 1960:		
Total membership		1,765
Members not receiving *Journal*		197
Members receiving *Journal*		1,568
Total paid subscriptions		609
Total mailing list		2,177

President Orr reviewed the problem of planning meetings more than one year in advance, following which Tracy Storer presented a suggested amendment to the Bylaws, Article IV, to read as follows:

> "*Sec. 1.* An annual stated meeting shall be held in accordance with action of the Society at the preceding annual meeting. In the event of no decision, the Directors are empowered to act. Also the Society may plan for meetings more than one year in advance. Due notice of such meetings shall be given by the Secretary-Treasurer."

The following were elected to office for 1960–61: Stephen D. Durrant, President; Emmet T. Hooper and Ian McT. Cowan, Vice-Presidents; Randolph L. Peterson, Recording Secretary; Donald F. Hoffmeister, Murray L. Johnson, James S. Findley, William O. Pruitt, Jr. and A. W. Frank Banfield, Directors for 1960–62. Reports of the Bibliography Committee, Editorial Committee, Committee on Honoraria, Index Committee, Committee on Marine Mammals, Membership Committee, and Committee on Honorary Memberships were presented and approved. The session adjourned at 12:45 PM.

The final business session convened at 10:50 AM, 22 June, with 84 members present. The report of the Committee on Conservation of Land Mammals was presented and approved. The report of the Committee on Nomenclature was presented by W. H. Burt. The report concerned two nomenclatural problems, viz., *Odocoileus* vs. *Dama* and *Citellus* vs. *Spermophilus*. In each case there were majority and minority reports (see page 537), the former favoring *Odocoileus* and *Citellus*, the latter favoring *Dama* and *Spermophilus*.

It was moved and passed that a preferential vote be taken on each question, and that the results of the polls be forwarded to the International Zoological Commission, together with the complete texts of both majority and minority reports. The polls showed the membership 74–1 in favor of *Odocoileus*, and 55–20 in favor of *Citellus*. Hoffmeister presented the report of the special committee for negotiating a contract for reissuing out-of-print volumes of the *Journal*. Reports of representatives to the National Research Council, the AIBS and the AAAS were presented.

Keith Kelson presented the following resolution which was adopted unanimously:

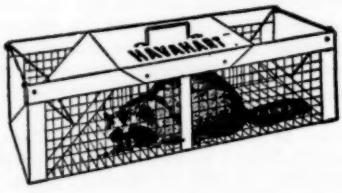
WHEREAS, The American Society of Mammalogists at its 40th Annual Meeting and first meeting in the Pacific Northwest has experienced a generous and considerate hospitality, has enjoyed excellent facilities, food and accommodations and the many other benefits of a diligent, well-organized and effective Local Committee and host institutions, and

WHEREAS, These features have contributed so materially to the professional profit and personal enjoyment of the members of the Society and have made this meeting an outstanding one in the history of the Society; now, therefore, be it

Resolved, That the American Society of Mammalogists, at its 40th Annual Meeting, 19 to 23 June 1960, at Tacoma, Washington, expresses its sincerest appreciation to Drs. Burton T. Ostenson and Murray L. Johnson, Co-Chairmen of the Local Committee, and to their committeemen, and to Drs. S. C. Eastvold and Franklin Thompson, Presidents of Pacific Lutheran College and the University of Puget Sound, respectively, the host institutions, for their many kindnesses and courtesies.

The University of Illinois was selected as the meeting place for 1961, the exact dates to be announced later. Concerning a site for the 1962 meeting, an informal poll showed 34 favored Middlebury College, Vermont, and 35 favored the University of New Mexico. The meeting adjourned at 12:15 PM.

HAVAHART HUMANE ANIMAL TRAPS



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(Prepared by the Index Committee)

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